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Exceptionally preserved specimens of *Portunus monspeliensis* (A. Milne Edwards, 1860) (Brachyura, Portunidae) from the Miocene of Sardinia (Italy)

Abstract - Some specimens of *Portunus monspeliensis* (A. Milne Edwards, 1860) (Brachyura, Portunidae) from the middle Miocene (Langhian) of Binu Mancu (Oristano, Sardinia) have very well-preserved cuticle, occasionally with traces of the original pigmentation. The collection also comprises an albinotic individual.

Key words: Decapoda, Portunidae, Miocene, Sardinia, preservation, albinism.

Riassunto - Conservazione eccezionale in alcuni esemplari di *Portunus monspeliensis* (A. Milne Edwards, 1860) del Miocene della Sardegna (Italia).

Vengono descritti ed illustrati alcuni esemplari di *Portunus monspeliensis* (A. Milne Edwards, 1860) (Brachyura, Portunidae) provenienti dal Miocene medio (Langhiano) di Binu Mancu (Oristano, Sardegna). Gli esemplari hanno la cuticola conservata molto bene e talora presentano tracce dell'originale pigmentazione. Tra il materiale esaminato è presente un individuo di colorazione albina.

Parole chiave: Decapoda, Portunidae, Miocene, Sardegna, conservazione, albinismo.

Introduction

Cenozoic decapods from Sardinia have a long history of study, for instance Meneghini (1857), A. Milne Edwards (1860), Mariani & Parona (1887), Parona (1887), Ristori (1886, 1888), Lovisato (1902), Lőrenthey (1909), Comaschi Caria (1950, 1956), Marras & Ventura (1991), and De Angeli & Marangon (1992). The specimens studied come from marly limestones or calcareous marls of Oligocene, Miocene, and Pliocene age (De Angeli & Garassino, 2006b).

The known species are: *Callianassa calaritana* Ristori, 1896; *C. desmarestiana* A. Milne Edwards, 1860; *C. pedemontana* Crema, 1895; *C.* cf. *rakosiensis*

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Lőrenthey, 1898; *C. subterranea* (Montagu, 1808); *Callianassa* sp. (Superfamily Callianassoidea Dana, 1852); *Galathea affinis* Ristori, 1886 (Superfamily Galatheoidea Samouelle, 1819); *Dardanus mediterraneus* (Lőrenthey, 1909); *Pagurus manzoni* (Ristori, 1888); *Pagurus* cf. *substriatus* A. Milne Edwards, 1861; *Pagurus* sp. (Superfamily Paguroidea Latreille, 1802); *Calappa* sp. indet.; *Mursiopsis*? sp. indet.? (Superfamily Calappoidea A. Milne Edwards, 1837); *Ebalia lamarmorai* Lőrenthey, 1909; *Hepatinulus lovisatoi* Lörenthey, 1909 (Superfamily Leucosioidea Samouelle, 1819); *Maja miocaenica* Lőrenthey, 1907; *M. squinado* (Herbst, 1788) (Superfamily Majoidea Samouelle, 1819); *Lobocarcinus sismondai* (von Meyer, 1843) (Superfamily Cancroidea Latreille, 1802); *Portunus monspeliensis* (A. Milne Edwards, 1860); *P. neogenicus* Müller, 1979; *P. hastatus* (Linnaeus, 1767); *Necronectes schafferi* Glaessner, 1929 (Superfamily Portunoidea Rafinesque-Schmaltz, 1815); *Xantho moldavicus* (Yanakevich, 1977), ?*X. lovisatoi* (Lőrenthey, 1907); and *Goneplax gulderi* Bachmayer, 1953 (Superfamily Xanthoidea MacLeay, 1838). The specimen of *Phlyctenodes irregularis* described by Ristori (1896) could be ascribed to *Daira speciosa* (Reuss, 1871) (De Angeli & Garassino, 2006b).

Portunus monspeliensis is common in middle Miocene strata of Sardinia and it has been reported from Cagliari (Monte S. Michele and Fangario), Oristano (Pianu, Magomadas, Flussio, and Tresnuraghes), and Sassari (Bonorva) by several authors but under different, synonymous, names: *Lupa hastata* Linnaeus, 1767; *Neptunus convexus* Ristori, 1888; and *N. granulatus* (A. Milne Edwards, 1860) (see Comaschi Caria, 1956).

This species is also known from the Miocene of Lecce (Puglia), S. Maria Vigliana (Emilia-Romagna), and Meduno (Friuli-Venezia Giulia) (Ristori, 1888; De Angeli & Garassino, 2006a). The record of *P. monspeliensis* from the Rupelian (lower Oligocene) of Bacino Ligure Piemontese is dubious. In fact, Allasinaz (1987) pointed out that specimens assigned to this species, discovered in Piedmont, could belong to a different subspecies of *P. monspeliensis*. Finally, this species has been also reported from Malta, Spain, Portugal, France, Hungary, Austria, Egypt, and the Sinai Peninsula (A. Milne Edwards, 1860; Ristori, 1888; Glaessner, 1928, 1933; Lőrenthey & Beurlen, 1929; Müller, 1979, 1984, 1993; Gatt, 2006). The descriptions and illustrations of this species usually refer to carapaces lacking exocuticle, and therefore the dorsal surface does not demonstrate the original ornament. Instead, small, ovoid, weakly raised tubercles typically are present on the outer part of the endocuticle.

The specimens from the marly limestone of the Langhian (middle Miocene) of Binu Mancu (the area between the villages of Flussio-Tresnuraghes-Magomadas) are exceptionally preserved and provide new data to our knowledge of this species (Fig. 1).

Material

Twelve specimens from the middle Miocene of Binu Mancu (Oristano, Sardinia) are housed in the Museo di Storia Naturale di Milano (MSNM). They are preserved three-dimensionally and their preparation was easy on account of the softness of the matrix.

The systematic arrangement used in this paper follows the recent classification proposed by Martin & Davis (2001).
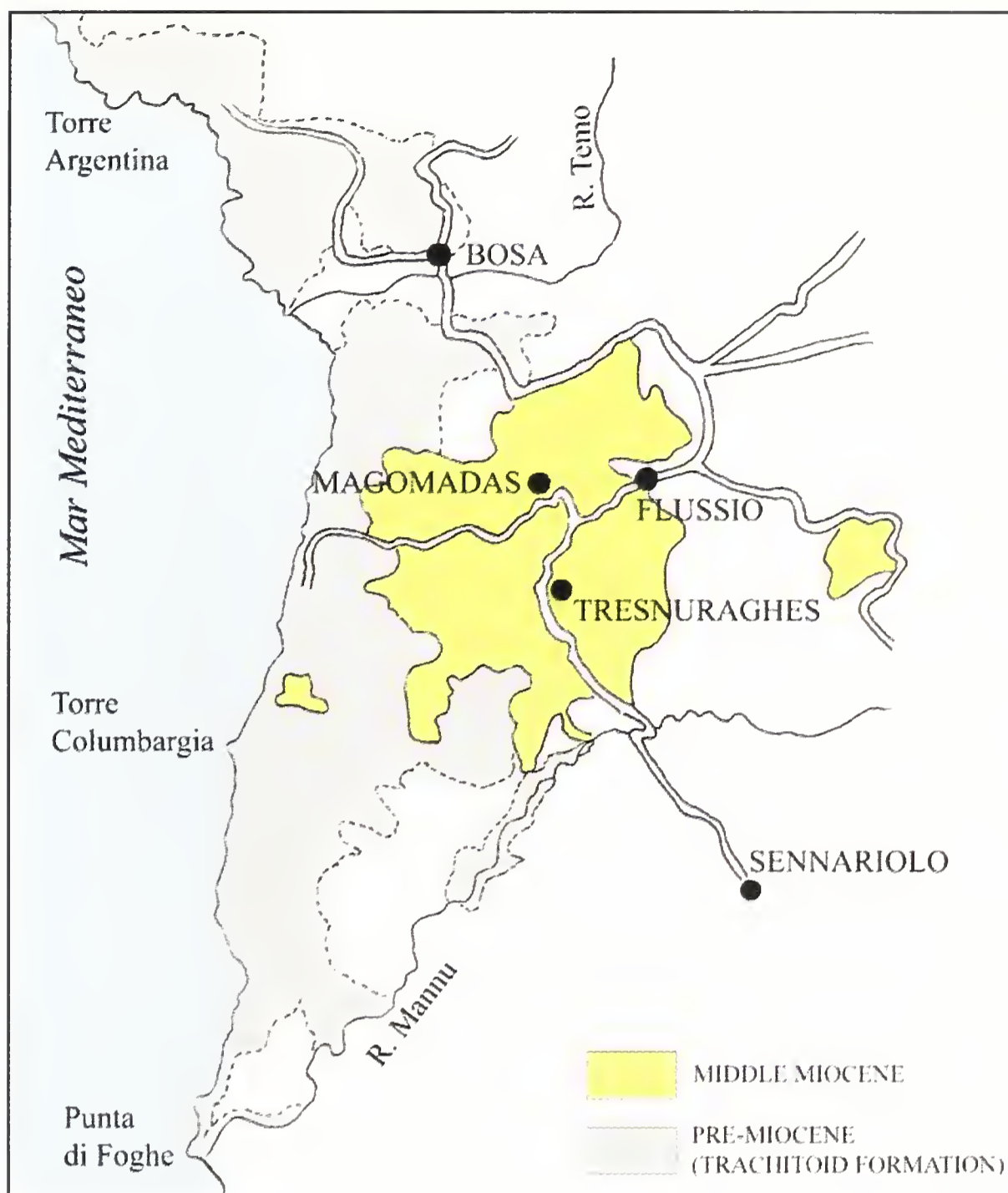
Fig. 1 - Geographical map of western Sardinia with the extent of the outcrop of middle Miocene strata and the provenance area of the material studied. / Carta geografica della Sardegna occidentale con gli affioramenti del Miocene medio da cui proviene il materiale studiato.

Systematic Palaeontology

Infraorder Brachyura Latreille, 1802
Subsection Heterotremata Guinot, 1977
Superfamily Portunoidea Rafinesque-Schmaltz, 1815
Family Portunidae Rafinesque-Schmaltz, 1815
Genus *Portunus* Weber, 1795

Type species: *Cancer pelagicus* Linnaeus, 1758.

Portunus monspeliensis (A. Milne Edwards, 1860)
Figs. 2-4

1860 – *Neptunus monspeliensis* A. Milne Edwards; p. 106, Pl. 4 (fig. 1), Pl. 5 (fig. 1)

1860 – *Neptunus granulatus* A. Milne Edwards; p. 115, Pl. 3 (fig. 1), Pl. 7 (fig. 2)
1888 – *Neptunus granulatus* A. Milne Edwards *in* Ristori; p. 215, Pl. 4 (figs. 5-11)
1893 – *Neptunus granulatus* A. Milne Edwards *in* Bittner; p. 11
1897 – *Neptunus monspeliensis* A. Milne Edwards *in* Roman; p. 128
1898 – *Neptunus granulatus* A. Milne Edwards *in* Lőrenthey; p. 92, Pl. 9 (figs. 2-3)
1901 – *Neptunus granulatus* A. Milne Edwards *in* Blanckenhorn; p. 76, 112
1909 – *Neptunus granulatus* A. Milne Edwards *in* Lőrenthey; p. 242, Pl. 2 (figs. 1-2)
1911 – *Neptunus granulatus* A. Milne Edwards *in* Toula; p. 48, Text-figs. 1-2
1927 – *Neptunus granulatus* A. Milne Edwards *in* Van Straelen; p. 86
1928 – *Neptunus granulatus* A. Milne Edwards *in* Glaessner; p. 183
1929 – *Neptunus granulatus* A. Milne Edwards *in* Glaessner; p. 267
1929 – *Neptunus granulatus* A. Milne Edwards *in* Lőrenthey & Beurlen; p. 188, Pl. 13 (figs. 3-4), Pl. 14 (figs. 1-4)
1950 – *Neptunus granulatus* A. Milne Edwards *in* Comaschi Caria; p. 326
1956 – *Neptunus granulatus* A. Milne Edwards *in* Comaschi Caria; p. 288, Pl. 1 (figs. 1-7), Pl. 2 (figs. 1-6), Pl. 3 (figs. 1-2)
1962 – *Neptunus granulatus* A. Milne Edwards *in* Zbyszewski & Da Veiga Ferreira; p. 286
1964-65 – *Neptunus granulatus* A. Milne Edwards *in* Da Veiga Ferrera; p. 150
1965 – *Neptunus granulatus* A. Milne Edwards *in* Varola; p. 296
1968 – *Neptunus* cfr. *N. granulatus* A. Milne Edwards *in* Stancu & Andreescu; p. 466, Pl. 7 (fig. 85)
1979 – *Portunus monspeliensis* (A. Milne Edwards) *in* Müller; p. 274, 280, 288, Pl. 18
1979 – *Portunus granulatus* A. Milne Edwards *in* Förster; p. 94
1984 – *Portunus monspeliensis* (A. Milne Edwards) *in* Müller; p. 79, Pl. 62 (figs. 1-2)
1987 – *Portunus monspeliensis* (A. Milne Edwards) *in* Allasinaz; p. 539, Pl. 4 (figs. 1-2)
1991 – *Portunus monspeliensis* (A. Milne Edwards) *in* Marras & Ventura; p. 108, Pl. 1, Pl. 2 (figs. 1-4), Pl. 3 (figs. 1-3)
1993 – *Portunus monspeliensis* (A. Milne Edwards) *in* Müller; p. 14, figs. 6G, 7A
2006a – *Portunus monspeliensis* (A. Milne Edwards) *in* De Angeli & Garassino; p. 283, fig. 8
2006b – *Portunus monspeliensis* (A. Milne Edwards) *in* De Angeli & Garassino; p. 59
2007 – *Portunus monspeliensis* (A. Milne Edwards) *in* Marangon & De Angeli; p. 70

Stratigraphic range: middle Miocene (Langhian).
Type locality: Binu Mancu (Oristano, Sardinia).
Occurrence: Twelve complete specimens ten of which show the dorsal surface (MSNM i26874, i26875, i26877, i26878, i26918-i26921, i26922, i26923), two the ventral surface (MSNM i26876, i26924).

Fig. 2 – *Portunus monspeliensis* (A. Milne Edwards, 1860), n. cat. MSNM i26874. A) carapace in dorsal view (carapace in norma dorsale) (x 1.6). B) close-up of dorsal coloration (particolare della colorazione dorsale) (x 2.5). C) right cheliped (chelipede destro) (x 1.8).
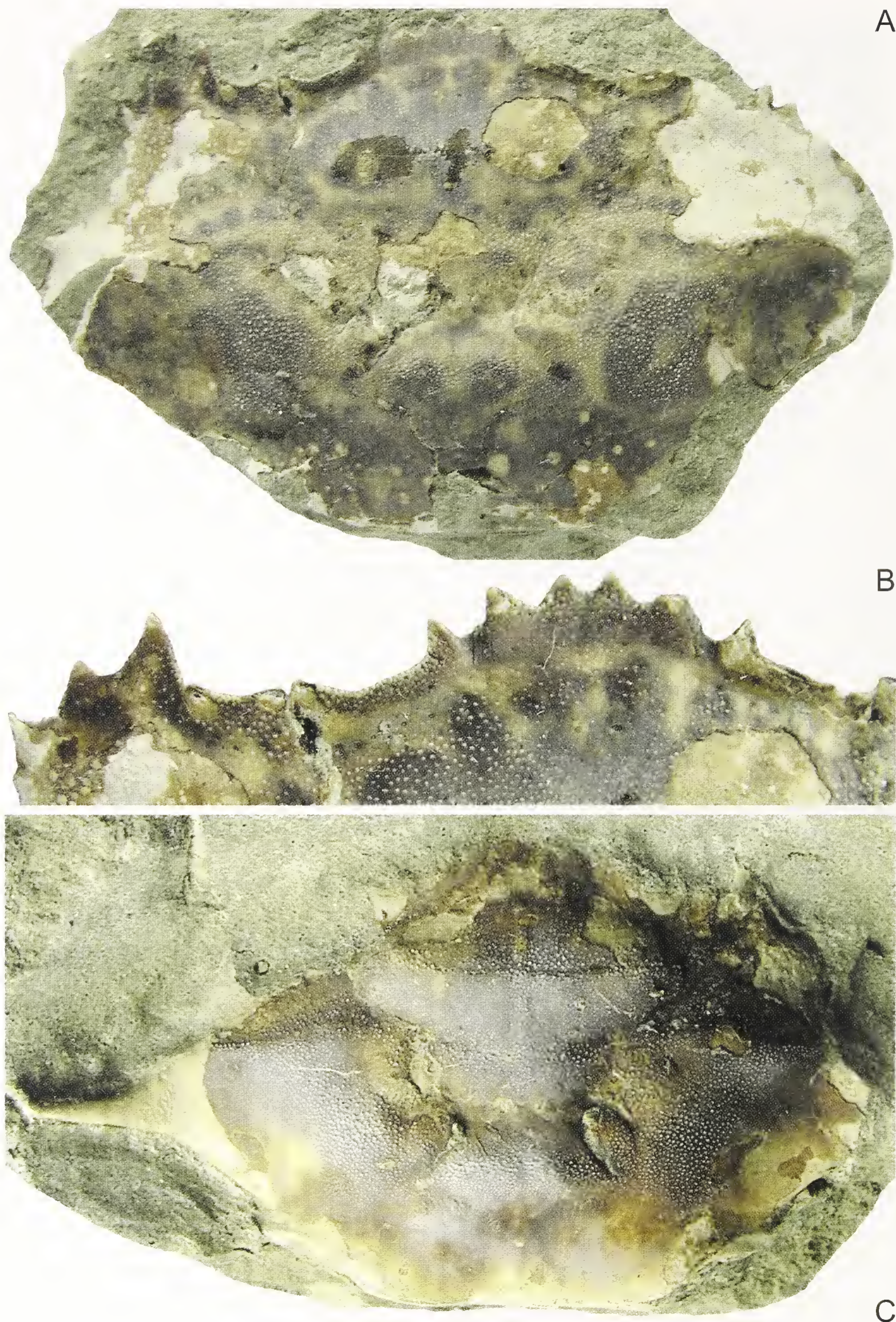
Fig. 3 – A-B) *Portunus monspeliensis* (A. Milne Edwards, 1860), n. cat. MSNM i26875. A) carapace in dorsal view (carapace in norma dorsale) (x 1.5). B) orbito-frontal margin (margine orbito-frontale) (x 2.5). C) *Portunus monspeliensis* (A. Milne Edwards, 1860), n. cat. MSNM i26878, carapace in dorsal view (carapace in norma dorsale) (x 1.5).

Fig. 4 – A) *Portunus monspeliensis* (A. Milne Edwards, 1860), n. cat. MSNM i26876, ventral view, fermale individual (visione ventrale, individuo femminile) (x 1.1). B) *Portunus monspeliensis* (A. Milne Edwards, 1860), n. cat. MSNM i26877, carapace in dorsal view (carapace in norma dorsale) (x 1).

Discussion. These specimens show the following morphological characters: original dorsal ornament; exocuticle with fine granulation, denser on metagastric, cardiac, and branchial regions; elongate supraorbital margin, interrupted by two narrow and finely granulate fissures (Fig. 3 A-B); extraorbital spine more strongly developed than the other seven spines along lateral margin; anterolateral spines decrease in size (excluding the elongate spine located on the angle); small granules also present on margins of the lateral spines; protogastric regions with transverse granulated crista; epibranchial regions crossed by a sinuous, granulated and transverse crest also extending onto the elongate spine of the anterolateral angle; posterolateral margin concave and with superficial granulated crest; sternite IV with transverse concavity and finely granulated anterior lateral margin (Fig. 4 A). The exocuticle of the carapace, chelipeds, sternites, and abdomen is always of a brown-purple colour (Fig. 3 A-C); many small white-yellowish areas are present on chelipeds and carapace surface (Fig. 2 A-C). These areas are larger on the posterior part of the dorsal surface and smaller and more uniform elsewhere. The carapace is brown-purple in colour and the areas are reduced or absent in other specimens. One specimen has a white exocuticle and brown-purple chelipeds with small white-yellowish areas (Fig. 4 B). The pigmentation of *P. monspeliensis* is similar to that of some Recent portunids along the American coasts [e.g. *Arenaeus cribrarius* (Lamarck, 1818), *Arenaeus mexicanus* (Gerstaecker, 1856)] which exhibit a carapace of grey or brown colour with small yellow or white areas. The fossil specimen with a white carapace (Fig. 4 B) may be a case of albinism. Previously, Rathbun (1930: 104) recorded occasional examples of albinism in *Callinectes sapidus* Rathbun, 1896.

The new specimens of *P. monspeliensis* from the Miocene of Sardinia constitute a unique data set in the fossil record in view of their retaining pigmentation, allowing documentation of variations in colour pattern within the same species.

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First record of *Maja squinado* (Herbst, 1788) (Decapoda, Brachyura, Majidae) from the Pliocene of Masserano, Biella (Piemonte, NW Italy)

Abstract - The record of *Maja squinado* (Herbst, 1788) (Majidae Samouelle, 1819) from the Pliocene of Masserano, Biella (NW Italy) is the first for this family in Piemonte. The discovery increases the knowledge of the carcinologic assemblage in the area and documents a wider geographical distribution of the species in the Pliocene. *Maja squinado* (Herbst, 1788) was previously reported from the Pliocene of Emilia Romagna, Lazio, Puglia and Sardegna. Moreover, its presence in the NW of the Mediterranean Sea (Paleo-Adriatic Basin) also indicates the northern limit of its spread into the old Pliocene padanian Gulf.

Key words: Decapoda, Brachyura, Majidae, Pliocene, Italy.

Riassunto - Prima segnalazione di *Maja squinado* (Herbst, 1788) (Decapoda, Brachyura, Majidae) nel Pliocene di Masserano, Biella (Italia nord-occidentale).

La scoperta di *Maja squinado* (Herbst, 1788) (Majidae Samouelle, 1819) nel Pliocene di Masserano, Biella (Italia nord-occidentale) è la prima segnalazione della famiglia nel bacino piemontese, che non solo incrementa le conoscenze carcinologiche dell'area, ma amplia anche la distribuzione geografica della specie nel Pliocene. *M. squinado* (Herbst, 1788) è stata precedentemente segnalata nel Pliocene dell'Emilia Romagna, Lazio, Puglia e Sardegna. La sua presenza nel NO del Mediterraneo (Bacino Paleo-Adriatico) rappresenta il limite più settentrionale di diffusione della specie all'interno dell'antico golfo Pliocenico padano.

Parole chiave: Decapodi, Brachyura, Majidae, Pliocene, Italia.

Introduction and geological setting

Recently, Garassino *et al.* (2004) recorded the presence of brachyurans and anomurans from several localities of the Cenozoic of Piemonte (NW Italy). In this study the following brachyurans were reported, *Calappa granulata* Linnaeus, 1758, *Ilia pliocenica* Ristori, 1819, *Eriphia* sp. as well as one anomuran, *Pagurus* sp., from the Pliocene of Masserano (Biella) (Fig. 1).

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Fig. 1 – Map of the Piemonte with the fossiliferous locality (*). / Regione Piemonte, con la località fossilifera (*).

The new record of *Maja squinado* (Herbst, 1788) increases the faunal assemblage of this area, enlarging the carcinological record from the Cenozoic of Piemonte. The Pliocene levels of Masserano also preserve a very rich and well documented malacological fauna, in addition to echinoderms and rare teeth of teleostean and chondrichtyan fishes (Pasini & Garassino, 2006).

The fossiliferous levels crop out along the eroded banks of the Osterla River. These levels consist of more or less compact coarse sands and grey siltstone-micaceous sands, alternating with arenaceous levels of Pliocene age, 4 meters thick (Garassino *et al.*, 2004).

The studied specimen comes from a level of compact micaceous siltstone, with associated disarticulate pelecypod mollusc shells and gastropod casts.

Previous reports of *Maja squinado* in Italy

Maja squinado (Herbst, 1788) was previously reported from the Pliocene of Arda River, (Piacenza, Emilia Romagna), Monte Mario, Farnesina (Roma, Lazio), Rocca Vecchia (Lecce, Puglia), and Alghero (Sardegna) (Meneghini, 1857; Ristori, 1891; Varola, 1981; Garassino & De Angeli, 2004; De Angeli & Garassino, 2006) (Fig. 2). Gemmellaro (1914) reported this species from the younger levels of the Pleistocene of Monte Pellegrino (Palermo, Sicilia).

Fig. 2 – Paleogeographic reconstruction of Italy in the Pliocene, with the fossiliferous localities of *M. squinado* (Herbst, 1778) (in grey lands above sea level) (modified, by Pinna, 1976). / Ricostruzione paleogeografia dell'Italia durante il Pliocene con le località di rinvenimento di *M. squinado* (Herbst, 1778) (in grigio le terre emerse) (modificata, da Pinna, 1976). 1) Masserano (Biella). 2) Arda River (Piacenza). 3) Monte Mario, Farnesina (Roma). 4) Rocca Vecchia (Lecce). 5) Alghero (Sardegna).

Material

One incomplete carapace is preserved in a compact little block of hard siltstone also including scattered moulds of shells belonging to different molluscs. The specimen is preserved as a natural three-dimensional cast with only small remains of the original external cuticle. Originally the specimen was partially covered by sediment and the preparation was made by air gravers, due to the hard nature of the surrounding rock.

The specimen is housed in the Paleontological Collections of the Museo di Storia Naturale di Milano (MSNM).

The measurements are expressed in millimetres.

The systematic palaeontology used in this paper follows the recent classification proposed by Martin & Davis (2001).

Systematic Palaeontology

Superfamily Majoidea Samouelle, 1819
Family Majidae Samouelle, 1819
Genus *Maja* Lamarck, 1801
Maja squinado (Herbst, 1788)
Figs. 3, 4

Type species: *Cancer squinado* Herbst, 1788, by original designation.

Geological age: Pliocene.

Occurrence and measurements: Masserano, Biella (Piemonte, NW Italy). One incomplete, well-preserved specimen in dorsal view.

MSNM i27212: length of carapace, 69; width of carapace, 70.

Fig. 3 – *Maja squinado* (Herbst, 1778), MSNM i27212 (x 1.2).

Description. Carapace, nearly complete excluding the frontal area, compressed and broken in the left posterior part, wide and more inflated posteriorly, pear-shaped in outline, longer than wide (when complete). Smooth granulate and spiny ornamentation on dorsal surface and five alternate main prominent spines along each lateral margin, decreasing in size and length from anterior to middle outline. Only first left anterior postorbital spine partially preserved in frontal area. Anterior postorbital spine stronger than lateral ones. Main spines slightly divergent from axis and directed upward. Branchial regions developed and inflated, well marked by the sinuous grooves, with a well developed central spine on each side, ranged horizontally with the 4th metagastric axial spine, similar in size. Only three posterior axial spines preserved among original five. Metagastric, cardiac, and intestinal regions inflated, distinct and bulbous, with about-central developed smooth spines located along longitudinal median axis. Pereiopods not preserved except for fragmentary remains of P4, broken and located along latero-posterior side of carapace. P4 straight and elongate with merus longer than other elements.

Discussion. Even though the specimen lacks the frontal region, chelipeds and almost all pereiopods, it shows many affinities with the morphology of *Maja* Lamarck 1801, and the peculiar characters of the living species *Maja squinado* (Herbst, 1788), as follows: piriform outline and size; form, arrangement and general distribution of the smooth spines and granulate tubercles of the carapace that is enlarged frontally and posteriorly but not distinctly humped; the lateral and the five axial spines are smaller and are facing in different ways than that in the other fossil and Recent species.

Therefore, on the basis of the above-mentioned characters, the studied specimen has been assigned to *M. squinado*. Moreover the evidence of a lateral
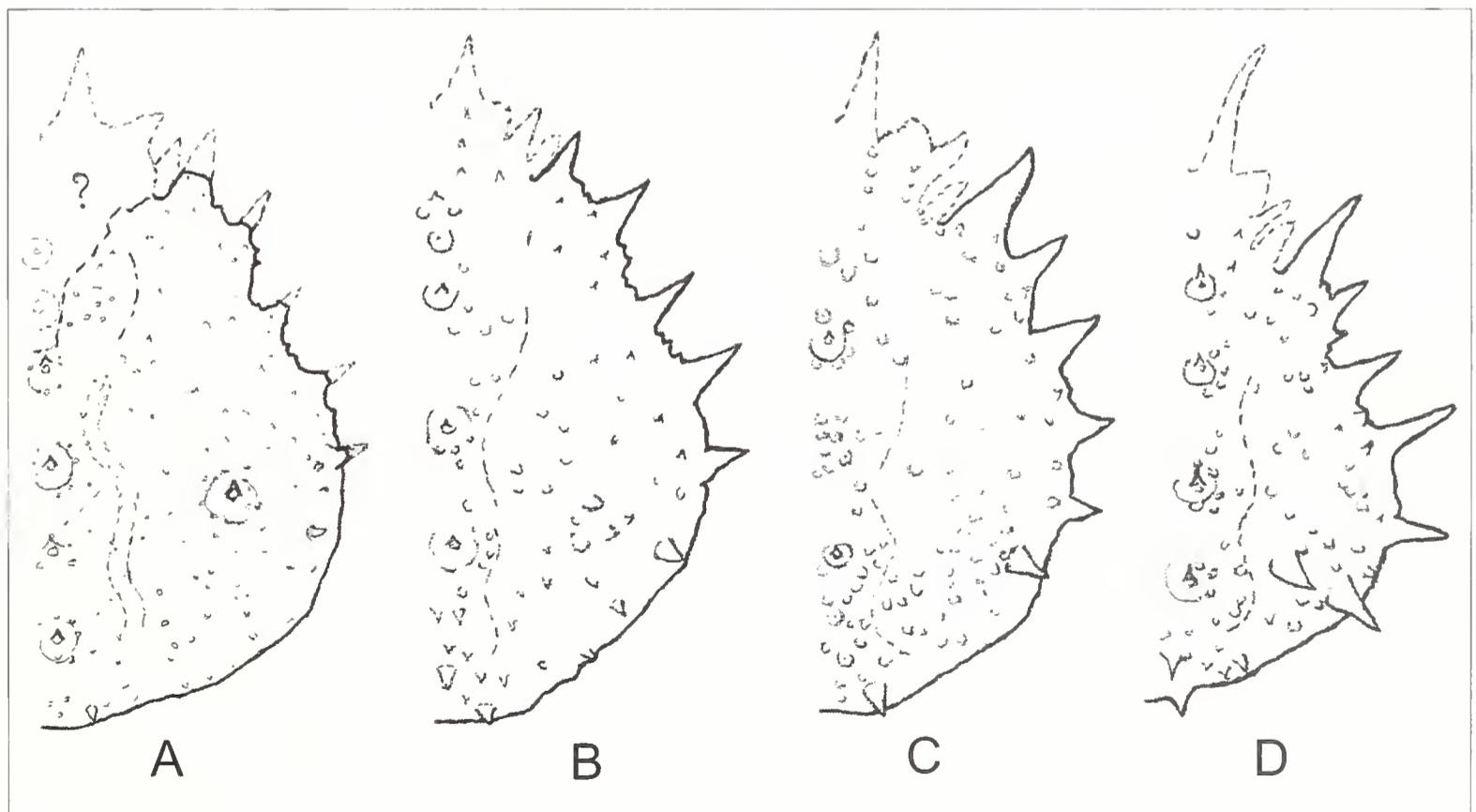
Fig. 4 – Comparison among the carapace outlines of the studied specimen and the Recent species of *Maja* living in the Mediterranean Sea (different scales). / (Confronto fra i profili del carapace dell'esemplare studiato e le specie viventi di *Maja* presenti nel Mediterraneo) (scale differenti). A) MSNM i27212. B) *M. squinado*. C) *M. crispata*. D) *M. goltziana*.

branchial spine on either side of the axial 4th may be explained as natural intraspecific variability or as related to the growth stage in living forms (G. P., pers. comm. 2008). However, the lack of more complete specimens does not allow more detailed discussion because the above-mentioned character is visible just on one single, incomplete specimen.

A further comparison was also made between the fossil coeval specimen (MG0603, housed in the Museo Geologico di Castell'Arquato, Piacenza, see Garassino & De Angeli, 2004) and with the two other Recent species of the genus, *M. crispata* Risso, 1827, and *M. goltziana* d'Oliveira, 1888, that are widespread in Mediterranean Sea. Both lack fossil records (Fig. 4). *Maja crispata* differs from the studied specimen in having stronger lateral spines, different tuberculate ornamentation, a carapace with five slightly spiny axial bulbous tubercles, a sharper and more pointed frontal region, different outline form and humped carapace, and a smaller body size in all growth stages. *Maja goltziana* differs in the general distribution and development of ornamentation of the humped carapace, with very long and pointed lateral spines, five elongated and proversed axial spines with two peculiar lateral ones on either side of the 4th spine, that is longer than the others, and arranged to form a cross-like form with the arms downward. The frontal region is stretched, and the body size is smaller, especially in adults specimens (d'Oliveira, 1888).

Conclusion

Even though the Recent *M. squinado* (Herbst, 1788) is considered today as the exclusive species widespread in the Mediterranean Sea, present in the distal and inner sublittoral zone on sandy, detritic or rocky bottoms and ranged about between 20 to 120 meters in depth, *Maja* is also represented by two other Mediterranean species, *M. crispata* Risso, 1827 (= *M. verrucosa* H. Milne Edwards, 1834), living in the north-east Atlantic between the Biscay Gulf to the western Morocco and in the Mediterranean Sea on soft and hard bottoms ranged from 0 to around 30 meters, and *M. goltziana* d'Oliveira, 1888, eurybathic species of subtropical origin (d'Udekem d'Acoz, 1999), widespread in the easthern Atlantic from Portugal to West Africa and South Mediterranean Sea.

Until the last century *M. squinado* was considered to be also distributed in the easthern Atlantic but today, the similar larger Atlantic specimens are ascribed to a different species, *M. brachydactyla* Balss, 1922, as confirmed by the review of all species of the genus conducted by Neumann (1998), and Sotelo *et al.* (2008)based on nonclinal morphological character differences of the first gonopods and multivariate analyses of morphometric measurements and genetic study. Therefore on the basis of these systematic evidences by Neumann (1988), the assignment of fossil specimens to *M. squinado* from the Pliocene and Pleistocene extra-Mediterranean area of North Europe (e.g. The Netherlands and northern Belgium), as reported by Holthuis (1949) and van Bakel *et al.* (2003), could be assigned to the easthern Atlantic species or to different undescribed species.

Finally, based upon the nature of preservation, kind and size, the studied specimen could represent an alloctonous moulting stage (exuvia) belonging to a subadult specimen. Moreover this fossil record indicates a widespread distribution of the species in all the Mediterranean Sea from the Pliocene.

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A new phyllosoma form (Decapoda, ?Palinuridae) from the Late Cretaceous (Cenomanian) of Lebanon

Abstract – A single specimen from the Late Cretaceous (Cenomanian) of Hadjula (Lebanon) is assigned to a phyllosoma stage (?Palinuridae Latreille, 1802). The phyllosoma stages known to date were reported only from the Upper Jurassic (Tithonian) of Germany. So the studied specimen represents, in the fossil record, the first report of a phyllosoma stage from the Late Cretaceous.

Key words: Decapoda, Palinuridae, phyllosoma stage, Late Cretaceous, Lebanon.

Riassunto – Prima segnalazione di fillosoma (Decapoda, ?Palinuridae) nel Cretacico superiore (Cenomaniano) del Libano.

Un esemplare, rinvenuto nel Cretacico superiore (Cenomaniano) di Hadjula (Libano), è attribuito allo stadio fillosoma (?Palinuridae Latreille, 1802). Attualmente, stadi fillosoma sono descritti solo nel Giurassico superiore (Titoniano) della Germania. L'esemplare studiato rappresenta quindi la prima segnalazione nel record fossile di uno stadio fillosoma nel Cretacico superiore.

Parole chiave: Decapoda, Palinuridae, fillosoma, Cretacico superiore, Libano.

Introduction and geological setting

The studied specimen was discovered in the limestone of Hadjula (Lebanon) from the Late Cretaceous (Cenomanian) (Dalla Vecchia *et al.*, 2002). The rich Lebanese decapod fauna was widely described by some authors (see Garassino & Schweigert, 2006, for complete references). Förster (1984), Garassino (1994, 2001) and Garassino & Schweigert (2006) reported some palinurid specimens, belonging to *Palinurus* sp. and *Linuparus* sp. (Palinuridae Latreille, 1802), *Palibacus praecursor* (Dames, 1886), *Jasus* sp. (Scyllaridae Latreille, 1825), and *Cancrinos libanensis* Garassino & Schweigert, 2006 (Cancrinidae Beurlen, 1930). Even though this new phyllosoma stage represents, in the fossil record, the first record from the Late Cretaceous, its state of preservation and the absence of certain morphological characters do

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not allow a comparison and ascription to one of the genera belonging to the above-mentioned families.

Previous studies on palinurids phyllosoma stages

The only decapod larvae discovered as fossils are phyllosoma stages of palinurids. These specimens were considered for many years as pantopods or confused with arachnids or other classes of arthropods (e.g. insects).

Polz (1970, 1971, 1972, 1973) described many specimens (complete sample of more than 1600 of which only some hundreds were analysed in the papers) from the Upper Jurassic (Tithonian) of Solnhofen (Bavaria, South Germany) as belonging to different early pelagic stages of palinurids or scyllarids. Later, Polz (1975) considered these specimens as exuviae belonging to different larval stages of palinurids. Polz (1970, 1973) described three different phyllosoma stages: Form A (= *Phalangites priscus* Münster, 1836), Form B (= *Palpipes cursor* Roth, 1851) and Form C (Polz, 1971, 1987) (= "*Dolichopus" tener* Walther, 1904). The author expressed also "the possibility of an hypotetical link between the different development series of the Forms B and C".

Finally, Polz (1995) recorded a fourth large palinurid phyllosoma stage, as Form D. Today, some authors considered *Phalangites priscus* Münster, 1836 (= *Phyllosoma prisca in* Frickhinger, 1994) as probable larval stage of ?eryonids (Frickhinger, 1994), *Palpipes cursor*, Roth 1851, is considered as an exuvia of a post-larval stage of *Palinurina sp*., and "*Dolichopus" tener* Walther, 1904, is now invalidated (Polz, 1971; Frickhinger, 1994). However, the ascription of these larval stages to palinurid fossil genera is still debated.

Previously this report, *Eryoneicus ?sahel-almae* Roger, 1944, was the only crustacean larval stage known to date from the Upper Cretaceous of Lebanon (Roger, 1944). Later, Glaessner (1969) considered erroneously the ascription of *E. ?sahel-almae* to a larval stage. Now, this species is considered by Aguirre-Urreta *et al.* (1990) as a postlarval crustacean stage of eryonid. Roger (1946) discussed another arthropod specimen from Sahel Alma, describing it as an arachnid of the Order Opiliones (= Phalangida Petry, 1833), *Opiliones* sp. At present, Polz (pers. comm., 2007) affirmed that this specimen is instead a phyllosoma stage, even though any author has never reviewed it. Moreover Polz (pers. comm., 2007) affirmed: "I own a poor preserved phyllosoma larva from Lebanon (Haqel) - donated by Dr. U. Hückel in 1975 - which represents an A4 embedding position" and also "... in the Geol. and Paleontol. Inst. at Tübingen, where then several phyllosoma larvae were housed in their Lebanese collection". Unfortunately the specimens of Tübingen were never recorded or described in scientific papers and we were unable to have their detailed information. For this reason we consider the studied specimen as the first record of phyllosoma stage from the Late Cretaceous of Lebanon.

Material

A single specimen in anatomical connection, flattened and compressed on the surface of a thick layer of yellow sub lithographic limestone. The specimen is housed in the Paleontological Collections of the Museo di Storia Naturale di Milano (MSNM). The measures, expressed in millimetres, were taken by a digital calliper.

Systematic Palaeontology

Infraorder Palinura, Latreille 1802
Superfamily Palinuroidea, Latreille 1802
?Family Palinuridae, Latreille 1802
Genus and species indeterminate
Figs. 1-2

Type locality: Hadjula (Lebanon).
Geological age: Late Cretaceous (Cenomanian).
Material: one specimen in dorsal view, well preserved and almost complete. MSNM i15175.
Maximum length: 23 (from the tip of the front to the end of the abdomen)
Maximum width of thorax: 6.7 (without pereiopods)
Maximum length of the thorax: 8.1
Maximum width of the abdomen: 5.7
Maximum length of the abdomen: 7.2 (without tail fan)
Length of the tail fan: approximately 4.6

Description

Carapace. The cephalic shield is not preserved, most probably, indicating an exuvia (Polz, 1975). Frontal part narrow and shallow with two well-developed orbital spines slightly divergent forming a prolongation of the margin.

Abdomen. Subrectangular somites I-V with a smooth median carina, narrowing caudally. Tail fan, folded under the abdomen, is not well-preserved.

Cephalic appendages. Poorly preserved antennulae having superimposed thin flagella creating a continuum with a probable very short rostrum. Antennal flagella with three distinct basal peduncles, moderately elongate with pointed distal extremity. Small and kidney shaped (or kidney?) eyes arranged externally to the front and the antennae, visible only by UV light. Short 1st maxilliped with three? short articulate segments and uncinate dactylus, also visible only by UV light. Second maxilliped with exopodite, converging toward three small median mandibular structures, subtriangular in shape, suboval and well mineralized. Third maxilliped, more than twice longer than second, wider, and biramous with well-developed exopodites.

Thoracic appendages. P1-4 biramous with well-developed and elongate exopodites starting from the basis and joining at merus. All exopodites, longer than merus, with rectangular basal segment and longer annulate and flagellate distal part, probably originally thinnish pinnulate. All endopodites with short and wide coax and basis, strong merus, short carpus, and elongate propodus narrowing distally. Dactyli of the pereiopods not visible. P1-4 directed forward, P5 directed backward, P5 right is disarticulated and very poorly preserved. P1 shorter than P2-5. P2 longer than P1, 3-5. Smooth ornamentation on pereiopods.

Abdominal appendages. Not preserved.

Discussion

The studied specimen shares some generic morphological features with phyllosoma stages and at the same time it has some peculiar morphological features. It has in common with the phyllosma stages, as follows: organization and body shape, membranous (unpreserved) cephalic shield, pedunculate eyes arranged externally

to the front probably for the presence of an elongate eye-stalk, elongate pereiopods with propodus longer than merus and short basis; exopodites on the P1-4; P1 shorter than P2, P2 longer than P1, 3-5. It differs from the phyllosoma stages as follows: frontal cuticular part of the cephalic region already well delineate, presence of well-developed orbital spines; well-developed subrectangular thorax, elongate and bifurcate pereiopods with well-developed annulate exopodites longer than merus, wide abdomen narrowing caudally with well-developed somites, fragments of the tail fan already well developed.

The studied specimen was compared with the different phyllosoma larval stages from the Upper Jurassic of Germany, particularly with the Form B Polz, 1970 (*Palpipes cursor* Roth, 1851), Form A Polz, 1970 (*Phalangites priscus* Münster,

Fig. 1 – Phyllosoma stage, MSNM i15175. Natural light / Luce naturale (x 4).

1836) (= *Phyllosoma prisca*), and Form D Polz, 1995, even though considering the different geological age and ecosystems. The studied specimen has in common with Form B the strong shape and disposition of the pereiopods, even though the German species has not the typical bifurcation with well-developed exopodites. Moreover Form B has well-developed antennae with very elongate flagella, already present in the palinurid adults, while it lacks the well-developed orbital spines, the broad abdomen and tail fan, well developed in the studied specimen. The Form A is distinct from the studied specimen in possessing different shape of the front, absence of rostrum, globular or oval shape of thorax, different disposition of the pereiopods, short exopodites, and narrow abdomen. Form D is too much peculiar in size, preservation and morphology; presumably a last larval stage perished when

Fig. 2 – Phyllosoma stage, MSNM i15175. Ultraviolet light / Luce ultravioletta (x 4).

molting to the puerulus and preserving the cephalic shield (Polz, 1995). For these reasons we don't find comparable characters with this unusual stage, if not in general characters, attesting an advanced larval stage also for the studied specimen. Holthuis (pers. comm.) suggested that Form D might be placed in the genus *Justitia* (Palinuridae Latreille, 1802) on account of its transversal grooves in the abdominal segments (Polz, pers. comm., 2007). Finally, the studied specimen was compared with different larval stages of extant palinurids, housed in the collection of the Département Milieux et Pouplements Acquatiques (Muséum national d'Histoire naturelle, Paris), without recognizing ontogenetic stages with similar morphological features.

Conclusion

The ontogeny of the larval fossil decapods is not well known because of their rare preservation in the fossil record. The ontogeny usually comprises the embrionic, larval, post-larval and adult stages. In Palinuroidea, the first postembryonic pelagic larva is a discoidal or leaf-shaped, long-legged phyllosoma, with a commonly setose and bifurcate nature of their appendages that serve as aid in flotation (Moore & Mc Cormick, 1969). We can recognise in the extant palinurid decapods many larval stages and sub-stages of phyllosoma, extremely different according to the genus. All these stages have a subcircular transparent body with membranous cephalic shield, pedunculate eyes, filiform and elongate pereiopods having radial arrangement around the thorax, biramous, with annulate and pinnulate exopodites. As already reported in the above-mentioned section, the comparison among the studied specimen and the fossil and extant phyllosoma stages pointed out some different morphological features. The studied specimen could represent one of the last phyllosoma stages for the cuticular mineralization of front and abdomen, long P5, and the presence of a developed tail fan. In fact, as pointed out by Polz (1987), these body structures usually appear only in the last larval stages in extant palinurids. We exclude that the studied specimen can belong to the Scyllaridae, a family without rostrum, different front outline and with very short antennal flagella. We suppose instead that the studied specimen could belong to the Palinuridae having orbital spines, moderately elongate antennal flagella, elongate pereiopods, with pereiopod II longer than the others, pereiopod I shorter and elongate sharp of the thorax. Finally, we suggest that the studied specimen could represent an exuvia belonging to unrecorded last stage (or Form) of phyllosoma, "pre-puerulus" of the family Palinuridae.

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Giacomo Bracchi & Enrico Romani

Flora esotica d'Italia: nuovi dati per l'Emilia-Romagna

Riassunto - Sono illustrati reperti floristici riferibili a entità nuove o interessanti per la flora esotica d'Italia. Tali reperti sono stati collezionati nel territorio delle Province di Piacenza e Parma (Regione Emilia-Romagna). *Coreopsis lanceolata* L., *Crepis dioscoridis* L., *Egeria densa* Planch., *Erigeron strigosus* Mühlenb. ex Willd., *Heracleum mantegazzianum* Sommier & Levier, *Najas gracillima* (A.Braun) Magnus, *Rudbeckia laciniata* L. var. *laciniata*, *Symphyotrichum novae-angliae* (L.) G.L.Nesom e *Symphytum asperum* Lepech. sono esotiche naturalizzate nuove o confermate per l'Emilia-Romagna; *Alcea biennis* Winterl subsp. *biennis*, *Broussonetia papyrifera* (L.) Vent., *Hemerocallis fulva* (L.) L., *Lemna minuta* Kunth, *Lepidium didymum* L., *Oxalis dillenii* Jacq., *Syringa vulgaris* L. e *Vitis labrusca* L. sono esotiche naturalizzate nuove o confermate per la Provincia di Piacenza; *Bergenia crassifolia* (L.) Fritsch, *Callistephus chinensis* (L.) Nees, *Caryopteris ×clandonensis* Hort., *Koelreuteria paniculata* Laxm., *Oenothera chicaginensis* Renner ex R.E.Cleland & Blakeslee, *Oxalis purpurata* Jacq., *Phyllostachys edulis* (Carrière) Houz., *Rudbeckia hirta* L. var. *hirta*, *Tagetes erecta* L. e *Tamarix parviflora* DC. sono esotiche casuali nuove per la Provincia di Piacenza e/o l'Emilia-Romagna.

Parole chiave: Neofite, Italia, Emilia.

Abstract - The alien flora of Italy: new data for Emilia-Romagna.

The manuscript discusses some news concerning the naturalized and casual Italian alien flora. Some significant specimens collected in the area between Piacenza and Parma (Regione Emilia-Romagna) are illustrated. *Coreopsis lanceolata* L., *Crepis dioscoridis* L., *Egeria densa* Planch., *Erigeron strigosus* Mühlenb. ex Willd., *Heracleum mantegazzianum* Sommier & Levier, *Najas gracillima* (A.Braun) Magnus, *Rudbeckia laciniata* L. var. *laciniata*, *Symphyotrichum novae-angliae* (L.) G.L.Nesom and *Symphytum asperum* Lepech. are naturalized neophytes that have never been found before or for a long time in Emilia-Romagna; *Alcea biennis* Winterl subsp. *biennis*, *Broussonetia papyrifera* (L.) Vent., *Hemerocallis fulva* (L.) L., *Lemna minuta* Kunth, *Lepidium didymum* L., *Oxalis dillenii* Jacq., *Syringa vulgaris* L. and *Vitis labrusca* L. are naturalized neophytes that have never been observed before or for a long time in the area of Piacenza; *Bergenia crassifolia* (L.) Fritsch, *Callistephus chinensis* (L.) Nees, *Caryopteris ×clandonensis* Hort., *Koelreuteria paniculata* Laxm., *Oenothera chicaginensis* Renner ex R.E.Cleland & Blakeslee, *Oxalis purpurata* Jacq., *Phyllostachys edulis* (Carrière) Houz., *Rudbeckia hirta* L. var. *hirta*, *Tagetes erecta* L. and *Tamarix parviflora* DC. are occasional neophytes tha may become soon established in Emilia-Romagna.

Key words: Neophytes, Italy, Emilia.

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Introduzione

L'avvento degli ultimi decenni del secolo scorso è coinciso con un notevole impulso alla ricerca inerente la flora vascolare italiana. Tale impulso è principalmente scaturito sia dalla pubblicazione della tuttora indispensabile "Flora d'Italia" di Pignatti (1982), sia dalla sempre maggiore diffusione di esperti, appassionati e amatori interessati all'indagine critica, tassonomica e corologica, di specifici gruppi sistematici, nonché all'esplorazione geobotanica di particolari aree del territorio nazionale. Il territorio di studio è spesso coinciso con ambiti amministrativi provinciali, ma talora anche con contesti geografici più ridotti, quali parchi, vallate, gruppi montuosi, zone umide, fasce fitoclimatiche, ecc...

Le più recenti testimonianze frutto di suddetta tendenza sono la realizzazione di una banca dati della flora vascolare italiana (Abbate *et al.*, 2004), la pubblicazione della *checklist* della flora vascolare italiana (Conti *et al.*, 2005, 2006), opera quest'ultima che offre un quadro sintetico e aggiornato delle entità presenti Regione per Regione, la stesura e l'applicazione di un progetto per la compilazione di una flora critica dell'Italia (Pignotti, 2006) ed infine il censimento della flora esotica d'Italia (Viegi *et al.*, 2005).

Relativamente alla Regione Emilia-Romagna, i sempre più territorialmente capillari progressi nella ricerca geobotanica hanno nel tempo condotto all'edizione di varie 'Flore' a calibratura provinciale (Cocconi, 1883; Bracciforti, 1887; Casali, 1899; Revedin, 1909; Bolzon, 1920; Alessandrini & Branchetti, 1997; Romani & Alessandrini, 2001) e interprovinciale (Gibelli & Pirotta, 1882; Zangheri, 1966; Mazzoni *et al.*, 2001; Bonali *et al.*, 2006a) nonché di atlanti corologici regionali (Alessandrini & Bonafede, 1996; Bonafede *et al.*, 2001).

Grazie anche all'apporto di numerose altre note floristiche più o meno datate e approfondite (Tab. 1) e di dati fitosociologici (Assini (1997, 1998, 2002, 2004) per il Po emiliano; Pellizzari & Piccoli (2001) per il Bosco della Mesola), suddette monografie hanno fornito un contributo decisivo alla compilazione della lista della flora esotica d'Italia naturalizzata in Emilia-Romagna e riportata nella *checklist* di Conti *et al.* (2005) attraverso la segnalazione di 260 entità aliene.

Tab. 1 – Principali note floristiche relative alla flora esotica naturalizzata in Emilia-Romagna. / Some references concerning the alien flora of Emilia-Romagna.

Taxon/Area di studio	Provincia	Rif. Bibl.
Cleome viscosa L.	MO	Vaccari (1941)
Artemisia annua L.	BO	Corbetta (1978)
Zone umide del Bolognese	BO	Corbetta *et al.* (1981)
Amaranthus rudis Sauer	PC	Soldano (1982)
Oenothera spp.	FE, PR, RE, RI, RV	Soldano (1992)
Delta del Po	FE	Pellizzari (1998), Piccoli & Pellizzari (2000)
Nicandra physalodes (L.) Gaertn.	RA	Contarini (1999)
Lemna minuta Kunth	FE	Piccoli *et al.* (1999)
Juncus tenuis Willd.	PC	Brilli-Cattarini (2001)
Solanum elagnifolium Cav.	RA	Marconi (2006)
Ludwigia peploides (Kunth) P.H.Raven	PC	Bonali *et al.* (2006b)
Matricaria discoidea DC.	RE	Branchetti *et al.* (2007)

Tuttavia, successivamente alla pubblicazione di Conti *et al.* (2005), gli autori del presente contributo hanno rilevato che alcune novità per la flora esotica dell'Emilia-Romagna sono desumibili sia dai *database* personali inediti sia da segnalazioni pubblicate più o meno contemporaneamente alla stessa *checklist* e da quest'ultima non assorbite (Tab. 2). Tali dati sono stati inseriti nell'opera relativa alla flora alloctona nazionale (Alessandrini *et al.*, in prep.) in cui, tra casuali e naturalizzate, sono elencate per l'Emilia-Romagna ben 330 entità (di cui 262 neofite), alcune delle quali rappresentano infestanti tra le più problematiche a livello nazionale e/o europeo.

Tab. 2 – Entità esotiche dell'Emilia-Romagna non riportate in Conti *et al.* (2005; 2006). / Alien flora of Emilia-Romagna not listed in Conti *et al.* (2005; 2006).

Taxon/Area di studio	Provincia	Rif. Bibl.
Cosmos bipinnatus Cav.	PR	Mazzoni *et al.* (2001)
Symphyotrichum novae-angliae (L.) G.L. Nesom	PR	Mazzoni *et al.* (2001)
Phedimus spurius (M.Bieb.) 't Hart	PC	Gallo & Bracchi (2005)
Sedum sarmentosum Bunge	PR	Gallo & Bracchi (2005)
Persicaria pensyvalnica (L.) M.Goméz	PC	Galasso & Bonali (2007)
Cota austriaca (Jacq.) Sch.-Bip.	RE	Branchetti *et al.* (2007)
Elymus obtusiflorus (DC.) Conert	RE	Branchetti *et al.* (2007)
Melilotus dentatus (Waldst. & Kit.) Desf.	RE	Branchetti *et al.* (2007)
Sporolobus neglectus Nash	RE	Branchetti *et al.* (2007)
Vitis riparia Michx.	MO	Galasso *et al.* (2007)
Aurinia saxatilis (L.) Desv. subsp. *megalocarpa* (Hausskn.) T.R. Dudley	BO	La Rosa & Peruzzi (2008)
Bidens bipinnata L.	BO	Alessandrini (2007)
Gamochaeta pensylvanica (Willd.) Cabrera	BO	Alessandrini & Galasso (2008)

I reperti floristici discussi nei paragrafi che seguono, collezionati nel territorio delle Province di Piacenza e Parma, rappresentano le più significative novità relative alla flora esotica d'Italia naturalizzata o casuale in Emilia-Romagna. I dati illustrati sono stati in buona parte acquisiti nell'ambito delle ricerche inerenti la flora alloctona d'Italia promosse tra il 2005 e il 2008 dal Ministero dell'Ambiente e della Tutela del Territorio, Direzione per la Protezione della Natura, e dal Centro Interuniversitario 'Biodiversità, Fitosociologia ed Ecologia' del Dipartimento di Biologia Vegetale dell'Università 'La Sapienza' di Roma in collaborazione con un ampio gruppo di lavoro facente capo alla Società Botanica Italiana (Viegi *et al.*, 2005; Alessandrini *et al.*, in prep.). Relativamente all'Emilia-Romagna, il censimento della flora esotica è stato effettuato tramite l'attività di campo e di verifica bibliografica applicata da G. Bracchi e E. Romani (Museo Civico di Storia Naturale di Piacenza), N. Merloni (Cervia, Ravenna), F. Piccoli e A. Pellizzari (Università di Ferrara) con il coordinamento di A. Alessandrini (Istituto dei Beni Culturali dell'Emilia-Romagna). Tuttavia, alcuni reperti illustrati nelle righe che seguono sono riconducibili in parte alle indagini geobotaniche promosse per il 2006 e il 2007 dal Settore Ambiente dell'Amministrazione Provinciale di Piacenza in collaborazione con la Società Piacentina di Scienze Naturali e il Museo Civico di Storia

Naturale di Piacenza nei Siti di Interesse Comunitario della Provincia (Ambrogio *et al.*, in stampa), in parte alla costante attività di censimento floristico dell'Emilia occidentale e del distretto appenninico ligure-emiliano applicate dagli autori del presente manoscritto.

Materiali e metodi

Nella fase di determinazione dei reperti illustrati nel successivo paragrafo, si è fatto sostanziale riferimento alle indicazioni suggerite nelle chiavi dicotomiche e nelle descrizioni di Pignatti (1982) e Tutin *et al.* (1964-1980), integrate o sostituite da quelle di altre opere nel caso dei generi *Bergenia* Moench (Jintang & Soltis, 2001), *Callistephus* Cassini (Cullen, 2000; Yilin *et al.*, in preparazione), *Coreopsis* L. (Strother, 2006a), *Egeria* Planch. (St. John, 1961), *Erigeron* L. (Nesom, 2006), *Hemerocallis* L. (Xinqi & Noguchi, 2000), *Heracleum L.* (Tiley *et al.*, 1996), *Koelreuteria* Laxm. (Nianhe & Gadek, 2000), *Lemna* L. (Landolt, 2000), *Najas* L. (Haynes, 2000), *Oxalis* L. (Eiten, 1963), *Oenothera* L. (Soldano, 1992), *Phyllostachys* Sieb. & Zucc. (Zhengping & Stapleton, 2006), *Rudbeckia* L. (Urbatsch & Cox, 2006), *Symphyotrichum* Nees (Brouillet *et al.*, 2006) e *Tagetes* L. (Strother, 2006b).

Sulla base dello schema per la valutazione del grado di naturalizzazione e invasività proposto da Richardson *et al.* (2000), si è preferito semplicemente suddividere le entità trattate in ordine alfabetico tra 'naturalizzate' e 'casuali'. Tale categorizzazione è basata su osservazioni inerenti diffusione, distribuzione, ecologia, densità, capacità di allontanarsi da eventuali 'centri' di coltura, capacità di automantenersi nel tempo e altri fattori relativi ai vari popolamenti osservati e valutati a più riprese nel tempo dagli autori del presente lavoro. Sono state quindi considerate 'naturalizzate' le entità che appaiono formare popolamenti più o meno stabili ma comunque capaci di automantenersi nel tempo anche in località lontane da eventuali centri di coltura. Sono state invece incluse tra le 'casuali' le entità per cui sono stati osservati popolamenti che fino ad oggi hanno mostrato sensibili fluttuazioni annuali e la cui eventuale persistenza dovrà essere meglio verificata nel tempo.

La nomenclatura dei *taxa* considerati segue Conti *et al.* (2005, 2006). La nomenclatura dei *syntaxa* citati segue Rivas-Martínez *et al.* (2001).

La maggior parte dei reperti (*exsiccata* e scansioni digitali su materiale fresco) relativi alle entità trattate nel paragrafo successivo sono stati depositati presso MSPC (Museo Civico di Storia Naturale di Piacenza), solo pochi negli erbari degli autori (Figg. 1-7). Per ogni reperto sono di seguito riportati: Provincia, Comune e Località della stazione di riferimento, data della raccolta/osservazione, altitudine, note ambientali, autore dell'erborizzazione/osservazione e della determinazione.

Risultati

Naturalizzate

Alcea biennis Winterl subsp. ***biennis*** (Malvaceae). Esotica nuova per la Provincia di Piacenza.

Reperti – PIACENZA: San Giorgio Piacentino, Loc. San Damiano, Giugno 2002, 130 m, incolto semiruderale lungo il greto del Torrente Nure a valle del paese (*leg. et det.* E. Romani; Fig. 1); Vigolzone, Loc. Villò, Giugno 2006, 190 m, lungo il greto del Torrente Nure in sponda sinistra (*leg. et det.* G. Bracchi).

Fig. 1 – *Alcea biennis* Winterl subsp. *biennis* (= *A. pallida*), S. Giorgio Piacentino, Loc. S. Damiano (PC), Giugno/June 2002.

Elemento pontico di interesse ornamentale, secondo Conti *et al.* (2005) naturalizzato in Veneto, Friuli-Venezia Giulia, Marche, Lazio e Abruzzo. La pianta è stata tuttavia rinvenuta come casuale anche in Lombardia nelle Province di Brescia (Pignatti, 1982, *sub A. pallida* (Willd.) Waldst. & Kit.), Sondrio (Aeschimann *et al.*, 2004) e Cremona (Bonali *et al.*, 2006a).

Nell'atlante corologico della flora vascolare della Provincia di Cremona, Bonali *et al.* (2006a) hanno cartografato, tra le altre, due stazioni localizzate in Provincia di Parma, le prime note per l'Emilia-Romagna.

Broussonetia papyrifera (L.) Vent. (Moraceae). Esotica confermata per la Provincia di Piacenza.

Reperti – PIACENZA: Piacenza, Loc. Bosco dei Santi, Giugno 2004, 45 m, margini dei prati intorno al paese (*leg. et det.* E. Romani, Fig. 2); Piacenza, Loc. Pittolo, Giugno 2005, 70 m, incrocio con la Strada Provinciale 45 'Val Trebbia' (*id.*); Ponte dell'Olio, Loc. Zaffignano, Luglio 2006, 190 m, nel fosso ai lati della Strada Provinciale (*id.*).

Albero originario dell'Asia orientale e introdotto nei paesi dell'Europa meridionale, dove è diffuso soprattutto in Romania, Spagna e Francia (Tutin, 1964). Già da Pignatti (1982) indicato come coltivato e naturalizzato negli ambienti ruderali di tutte le Regioni italiane. L'unica segnalazione ad oggi nota per il Piacentino era tuttavia quella di Bracciforti (1877): «Coltivasi in parecchi luoghi della provincia per formar siepi, e trovasi talora inselvatichita qua e colà [...]». La diffusione della specie in Emilia è peraltro desumibile anche dalla recente opera di Bonali *et al.* (2006a) sulla flora del Cremonese, dove sono cartografate alcune stazioni localizzate nella pianura parmense.

Coreopsis lanceolata L. (Asteraceae). Esotica nuova per l'Emilia-Romagna.

Reperti – PIACENZA: Monticelli d'Ongina, Loc. Isola Serafini, Giugno 2002, 40 m, sabbioni presso il ponte (*leg. et det.* E. Romani, Fig. 3).

Pianta di interesse ornamentale originaria degli Stati Uniti centrali e sud-occidentali dove cresce preferibilmente in incolti ruderali su suolo sabbioso (Strother, 2006a). Non è citata né in 'Flora Europaea' (Tutin *et al.*, 1964-1980) né in Flora d'Italia (Pignatti, 1982), mentre secondo Conti *et al.* (2005) è naturalizzata solo in Friuli-Venezia Giulia. In letteratura sono tuttavia documentate la presenza in Svizzera e Francia (Lonechamp, 1999; Aeschimann & Heitz, 2005) e l'invasività per Giappone, Australia (Auld *et al.*, 2003; Miyawaki & Washitani, 2004) e Nuova Zelanda (Webb, 1987).

Secondo le ripetute osservazioni di chi scrive, il popolamento cui fa riferimento il reperto correlato pare ben assestato anche perché a più riprese osservato fino all'estate 2007.

Crepis dioscoridis L. (Asteraceae). Esotica nuova per l'Emilia-Romagna e confermata per l'Italia.

Reperti – PIACENZA: San Giorgio Piacentino, Loc. San Damiano, Maggio 2007, 140 m, nel greto consolidato del Torrente Nure (*leg. et det.* E. Romani).

Pianta annuale originaria della regione egea, distribuita dall'Albania alla Grecia alla Turchia (Babcock, 1947). Nella cartina distributiva proposta da Pignatti (1982) è data come presente in Piemonte, Toscana, Lazio e Campania, con la precisazione che si tratta di avventizia rara e incostante. Secondo Conti *et al.* (2005, 2006), in Italia è naturalizzata, dubitativamente solo in Campania. Oltre che in Italia è naturalizzata anche in Francia e Croazia (Sell, 1976).

Egeria densa Planch. (Hydrocharitaceae). Esotica nuova per l'Emilia-Romagna.

Fig. 2 – *Broussonetia papyrifera* (L.) Vent., Piacenza, Loc. Pittolo, Giugno/June 2005.

Fig. 3 – *Coreopsis lanceolata* l., Monticelli d'Ongina, Loc. Isola Serafini, Giugno/June 2002.

Reperti – PIACENZA: Monticelli d'Ongina, Loc. Casa Bonissima Fermi, Giugno 2004, 40 m, canale a monte della chiusa di Isola Serafini (*leg. et det.* E. Romani); Monticelli d'Ongina, Loc. Cascina Scazzola, Maggio 2005, 40 m, nelle acque del Cavo Valle (G. Bracchi *obs.*).

Idrofita rizomatosa di origine sudamericana, introdotta in Europa attraverso l'applicazione di pratiche di aquariofilia e di tecniche di fisiologia vegetale (Wallentinus, 2002). Sia da Pignatti (1982) sia da Conti *et al.* (2005) indicata solo per Piemonte e Lombardia, dove è sicuramente presente nelle Province di Milano (Banfi & Galasso, 1998), Cremona (Bonali *et al.*, 2006a), Varese (Macchi, 2005), Brescia, Como (Aeschimann *et al.*, 2004), Verbania (Antonietti, 2005) e Novara (Pistarino *et al.*, 1999). E' tuttavia nota anche per la Toscana, Provincia di Pisa (Garbari & Borzatti Von Loewenstern, 2005). Naturalizzata anche in Austria, Belgio, Estonia, Francia, Germania, Gran Bretagna, Grecia, Olanda e Svizzera (Dandy, 1980; Wallentinus, 2002).

Nelle località indicate relativamente ai reperti correlati, localizzate ai margini del Sito di Interesse Comunitario IT 4010018 'Fiume Po da Rio Boriacco a Bosco Ospizio', la specie sta gradualmente invadendo, in qualità della spiccata capacità di riproduzione vegetativa, comunità del *Ranunculion aquatilis* Passarge 1964 che si esprimono tramite la dominanza di *Callitriche stagnalis* Scop.

Erigeron strigosus Muhlenb. ex Willd. (Asteraceae). Esotica confermata per l'Emilia-Romagna.

Reperti – PIACENZA: Coli, Lago di Averaldi, Settembre 2005, 1.090 m, banchina della Strada Provinciale Sant'Agostino nei pressi del Lago di Averaldi (*leg. et det.* G. Bracchi).

Le specie del gruppo di *E. annuus* (L.) Desf. (*Erigeron* sect. *Phalacroloma* (Cass.) Torr. & A.Gray) come quella in questione sono originarie del continente nordamericano, diffuse dalle Grandi Pianure alla costa atlantica, sporadiche sulle Montagne Rocciose e negli Stati Uniti orientali (Noyes, 2000; Noyes & Allison, 2005). *E. annus s. l.* è ampiamente naturalizzata in tutto il continente europeo e distribuita in gran parte delle Regioni italiane (Pignatti, 1982; Conti *et al.*, 2005, 2006).

E. strigosus (= *Erigeron annuus* (L.) Pers. subsp. *strigosus* (Muhlenb. ex Willd.) Wagenitz) è entità generalmente negletta, da Pignatti (1982) solo citata, in altre flore ignorata o sinonimizzata con *E. annuus* subsp. *annuus* (Conti *et al.*, 2005). Tuttavia, come hanno dimostrato gli studi di Noyes (2000, 2006) sulle sequenze ITS e ETS del DNA ribosomiale, *E. strigosus* rappresenta in realtà un *taxon* ben distinto anche dal punto di vista biomolecolare: se ne distinguono quattro varietà corrispondenti ad altrettante popolazioni diploidi degli Stati Uniti sud-orientali. Morfologicamente, le foglie cauline intere, le proporzioni delle parti fiorali e la distribuzione della pelosità sul fusto sono i caratteri che meglio differenziano *E. strigosus* in seno alla sect. *Phalacroloma* (Nesom, 2006).

Nonostante secondo Frey *et al.* (2003) non esistano prove dell'effettiva presenza in Europa, *E. strigosus* è stata tuttavia considerata nella recente opera di Aeschimann *et al.* (2004), in cui la cartografia distributiva ne riporta la presenza in alcune province di Piemonte, Lombardia e Veneto oltre che in altri distretti della catena alpina. Inoltre, Del Guacchio & Gargiulo (2006) hanno recentemente segnalato (*sub E. annuus*) per l'Abruzzo l'esistenza di popolamenti attribuibili all'entità in questione.

E. annuus è diffusa lungo strade e in vecchi prati, spesso in incolti umidi, mentre *E. strigosus* tende più comunemente a colonizzare ambienti più secchi, spesso localizzati ai margini delle foreste (Calzavara, 1979; Noyes & Allison, 2005).

Hemerocallis fulva (L.) L. (Hemerocallidaceae). Esotica confermata per la Provincia di Piacenza.

Reperti – PIACENZA: Gossolengo, Loc. Quartazzola, Giugno 2002, 75 m, lungo la Strada Comunale (*leg. et det.* E. Romani); San Giorgio Piacentino, Loc. Centovera, Maggio 2003, 120 m, lungo la Strada Comunale (km 3) (*id.*).

Pianta originaria delle foreste di Cina, India, Giappone e Russia, dove è diffusa con almeno quattro varietà tra 300 e 2.500 m s.l.m. (Xinqi & Noguchi, 2000). Coltivata per ornamento e ampiamente naturalizzata in gran parte dell'Europa centro-meridionale, nel vecchio continente compare lungo fossi, greti fluviali e habitat rocciosi (Webb, 1980).

Da Pignatti (1982) indicata per tutte le Regioni dell'Italia settentrionale fino all'Emilia-Romagna e per la Campania. In Conti *et al.* (2005, 2006) riportata per tutte le Regioni, con l'esclusione di Valle d'Aosta, Toscana, Campania Molise e Sardegna.

Relativamente alla Provincia di Piacenza era fino ad oggi disponibile un'unica segnalazione di Bracciforti (1877): «Si coltiva e si è ora naturalizzata alle sponde dei fossati».

Heracleum mantegazzianum Sommier & Levier (Apiaceae). Esotica nuova per l'Emilia-Romagna.

Reperti – PIACENZA: Ferriere, Loc. Casaldonato, Luglio 2003, 870 m, incolti lungo le sponde di un fosso tra la Chiesa e la Strada Comunale che scende verso Ferriere (G. Bracchi & E. Banfi *obs.*).

Specie originaria del Caucaso meridionale e di relativo interesse ornamentale più che altro legato alle notevoli dimensioni (fusto alto fino a 500 cm, foglie lunghe fino 300 cm). Da Viegi *et al.* (1973) e Pignatti (1982) segnalata solo per Valle d'Aosta e Toscana, in Aeschimann *et al.* (2004) e in Conti *et al.* (2005) riportata anche per Trentino-Alto Adige e Veneto. Più recentemente indicata come naturalizzata anche in Piemonte, Province di Novara, Verbania e Biella (Pistarino *et al.*, 1999; Antonietti, 2005; Pedullà *et al.*, 2006), e Lombardia, Provincia di Bergamo e Brescia (Galasso *et al.*, 2007b). Negli ultimi cinquant'anni il suo areale ha subito un costante ampliamento a livello europeo (Pyšek & Pyšek, 1995; Tiley *et al.*, 1996; Wallentinus, 2002), tanto da indurre l'applicazione di specifici progetti di contenimento in diversi paesi europei tra cui Irlanda (Caffrey, 2001), Scozia (Tiley & Philp, 1992), Repubblica Ceca (Pyšek, 1991; Moravcová *et al.*, 2006) e altri, anche perché si tratta di pianta avente capacità di infestare fitocenosi ripariali e di determinare gravi reazioni allergiche di natura dermatologica (Derraik, 2007).

Infatti, in accordo con quanto osservato per il reperto qui considerato, la specie è tipica di ambienti disturbati ad alta produttività, come quelli ripariali, piuttosto che di ambienti a bassa produttività dominati da specie stress-tolleranti (Hitchmough & Woudstra, 1999).

Lemna minuta Kunth (Lemnaceae). Esotica nuova per la Provincia di Piacenza.

Reperti – PIACENZA: Monticelli d'Ongina, Loc. Casazza, Giugno 2004, 40 m, in un fosso (*leg. et det.* E. Romani); Monticelli d'Ongina, Loc. Casa Bonissima Fermi, Giugno 2004, 40 m, canale a monte della chiusa di Isola Serafini (*id.*); Villanova sull'Arda, Loc. Due Ponti, Luglio 2004, 40 m, nelle acque del Cavo Fontana Alta (*id.*).

La prima segnalazione per l'Italia di questa pleustofita nativa del continente americano è in Desfayes (1992) e riguarda l'Italia nord-orientale, area dove è stata più tardi ritrovata anche da Prosser & Sarzo (2003). Dopo nemmeno due decadi dalla prima segnalazione, appare oggi sempre più capillarmente diffusa nelle acque mesotrofiche e eutrofiche della Pianura Padana dove, secondo le osservazioni di chi scrive, tende a invadere le comunità del *Lemnion minoris* Tüxen ex O.Bolós & Masclans 1955. In tempi recenti è stata segnalata per la prima volta anche in Italia centrale e meridionale, più precisamente in Puglia (Beccarisi & Ernandes, 2007), Abruzzo (Iberite *et al.*, 2008a) e Lazio (Iberite *et al.*, 2008b), oltre che in Lombardia, Province di Cremona (Bonali *et al.*, 2006a; Antoniotti e Petraglia, 2007) e Milano (Brusa *et al.*, 2006), Veneto, Provincia di Verona (Mazzotti & Pellizzari, 1999; Pellizzari & Piubello, 2005), e Friuli-Venezia Giulia (Poldini *et al.*, 2001). In Veneto come in Emilia-Romagna è nota per alcune stazioni dell'area del delta del Po (Piccoli *et al.*, 1999; Pellizzari & Piccoli, 2001).

Attualmente diffusa nella maggior parte dei paesi europei tra cui Inghilterra e Spagna (Sanz-Elorza *et al.*, 2001), Francia (Brunel & Tison, 2005), Germania (Gollasch & Nehring, 2006), Svizzera (Weber, 1999; Aeschimann & Heitz, 2005), Gran Bretagna, Belgio e Olanda (Wallentinus, 2002).

Lepidium didymum L. (Brassicaceae). Esotica nuova per la Provincia di Piacenza.

Reperti – PIACENZA: Cortemaggiore, Aprile 2006, 50 m, sui marciapiedi presso la Scuola Media (*leg. et det.* E. Romani).

Pianta di origine nordamericana, divenuta subcosmopolita grazie alla capacità di colonizzare attivamente incolti ruderali e calpestati. Secondo Conti *et al.* (2005) è naturalizzata in tutte le Regioni italiane eccetto Molise ed Emilia-Romagna. Tuttavia, in quest'ultima Regione è stata recentemente trovata da Alessandrini (comunicaz. pers.) in Provincia di Ferrara. Inoltre, in Provincia di Cremona è sta individuata presso alcune località prossime al confine emiliano (Bonali *et al.*, 2006a).

Nella stazione cui fa riferimento il reperto sopra indicato, la specie dissemina abbondantemente ma, a dispetto dei sopralluoghi in precedenza effettuati da uno di noi (E. R.), non era mai stata notata.

Najas gracillima (A.Braun ex Engelm.) Magnus (Najadaceae). Esotica nuova per l'Emilia-Romagna.

Reperti – PIACENZA: Caorso, Loc. Bondiocca, Luglio 2005, 40 m, lanche lungo il Po (*leg. et det.* G. Bracchi).

Idrofita rizomatosa originaria del continente nordamericano dove è diffusa nelle grandi pianure nord-atlantiche e nella regione dei grandi laghi (Wentz & Stuckey, 1971). Sia Pignatti (1982) che Conti *et al.* (2005) la indicano esclusivamente per Piemonte e Lombardia, dove è presente in Provincia di Milano e Pavia (Pirola, 1964; Banfi & Galasso, 1998) e probabilmente in gran parte delle Province piemontesi (Aeschimann *et al.*, 2004) tra cui senza dubbio quelle di Novara (Pistarino *et al.*, 1999) e Biella (Soldano & Sella, 2000), spesso in ambienti di risaia. Esistono tuttavia segnalazioni anche per il Veneto (Aeschimann *et al.*, 2004), Provincia di Verona, e per la Toscana (Garbari & Borzatti Von Loewenstern, 2005), Provincia di Pisa. Oltre all'Italia, l'unica altra nazione europea in cui pare essere attualmente naturalizzata è la Spagna (Valentine, 1980; Masalles *et al.*, 1996), dove è considerata specie rappresentante potenziale minaccia per gli ecosistemi acquatici (Sanz-Elorza *et al.*, 2001).

La località indicata tra i reperti correlati è localizzata entro il Sito di Interesse Comunitario IT 4010018 'Fiume Po da Rio Boriacco a Bosco Ospizio', poco a nord dell'impianto nucleare di Caorso, in una lanca le cui acque sono dominate da *Myriophyllum spicatum* L. e *Ceratophyllum demersum* L. tra le idrofite radicanti, *Lemna minor* L., *Spirodela polyrrhiza* (L.) Schleid e *Wolffia arrhiza* (L.) Wimm. tra le idrofite natanti.

Oxalis dillenii Jacq. (Oxalidaceae). Esotica nuova per la Provincia di Piacenza.

Reperti – PIACENZA: Ferriere, Loc. Ponte Nano, Settembre 2003, 530 m, greto del Torrente Nure (*leg. et det.* G. Bracchi); Ferriere, Loc. Casaldonato, Giugno 2006, 880 m, prati presso il cimitero (G. Bracchi *obs.*).

Indicandone la spontaneizzazione per Sardegna, Abruzzo e Lazio, Pignatti (1982) presagiva che questa entità, originaria degli Stati Uniti orientali e solo quarant'anni fa considerata rara in Europa (Eiten, 1963), fosse in realtà più diffusa nel territorio italiano. Infatti, poco più tardi veniva segnalata come stabilmente insediata in Friuli-Venezia Giulia (Jogan, 1997; Melzer, 1997), Veneto (Bianchini & Curti, 1992; Curti & Scortegagna, 1998), Trentino (Prosser, 2000, 2002), Marche (Viegi *et al.*, 2003a), Umbria (Viegi *et al.*, 2003b), Emilia-Romagna (Alessandrini & Branchetti, 1997; Branchetti *et al.*, 2007), Toscana (Garbari & Borzatti Von Loewestern, 2001) e in tutte le altre Regioni con l'eccezione di Puglia, Calabria e Sicilia (Conti *et al.*, 2005). Pur non essendo prima di oggi mai stata ufficialmente segnalata per il Piacentino, in questo territorio è gia stata trovata da Bonali *et al.* (2006a) presso il confine con la Provincia di Cremona. Naturalizzata anche in Svizzera, Austria e Slovenia, è tipica di ambienti ruderali e segetali e spesso compare nei pressi di cimiteri dove è talora utilizzata come ornamentale (Melzer, 1986; Jogan, 1997; Prosser, 2000; Aeschimann & Heitz, 2005).

Rudbeckia laciniata L. var. ***laciniata*** (Asteraceae). Esotica confermata per l'Emilia-Romagna.

Reperti – PIACENZA: Ferriere, Loc. Selva, Agosto 2006, 1.190 m, incolto ruderale lungo la strada che conduce al Passo del Crociglia (*leg. et det.* E. Romani). Ponte dell'Olio, Settembre 2007, 190 m, denso popolamento nel greto del Torrente Nure a monte del ponte stradale in destra idrografica (*leg. et det.* G. Bracchi).

Pianta perenne diffusa nelle zone umide delle praterie degli Stati Uniti orientali con cinque varietà (Urbatsch & Cox, 2006). Secondo Pignatti (1982) naturalizzata in tutti i contesti regionali dell'area padana «[...] dal Veneziano al Vercellese [...]», Emilia-Romagna inclusa. Con l'aggiunta di Trentino-Alto Adige, Friuli-Venezia Giulia e Abruzzo, suddetto quadro distributivo si evince anche da Aeschimann *et al.* (2004) e Conti *et al.* (2005), autori quest'ultimi che per l'Emilia-Romagna ammettono solo la presenza dubitativa della specie in questione.

Introdotta in Europa già nel XVII secolo quale pianta ornamentale, le prime segnalazioni che ne documentano la diffusione nel vecchio continente risalgono alla seconda metà dell'Ottocento e riguardano alcuni paesi della regione mitteleuropea tra cui Austria, Svizzera, Germania, ex-Cecoslovacchia e Ungheria (Kerner, 1871; Pyšek *et al.*, 2002), aree dove è oggi considerata una delle specie esotiche con il maggiore potenziale di invasività con particolare riferimento agli ambienti ripariali (Weber & Gut, 2005), grazie soprattutto alle notevoli dimensioni (fino a 2 m di altezza) e al denso fogliame (Jalas, 1993; Francirková, 2001). Anche negli ambienti ripariali di Giappone, Australia (Auld *et al.*, 2003; Miyawaki & Washitani, 2004) e Nuova Zelanda (Webb, 1987) si comporta come specie esotica invasiva.

Attualmente diffusa in tutta Europa con l'eccezione dei paesi nordici, nella letteratura fitosociologica mitteleuropea è considerata elemento caratteristico di fitocenosi di corsi d'acqua, zone umide e incolti ruderali riconducibili all'ordine *Convolvuletalia sepium* Tüxen ex Mucina 1993 (Kopecky, 1967; Lohmeyer, 1971; Holzner *et al.*, 1978), pur penetrando con una certa frequenza in comunità ascrivibili a *Bidentetalia tripartitae* Br.-Bl. & Tüxen ex Klika & Hadač 1944 (Görs & Müller, 1969), *Prunetalia spinosae* Tüxen 1952 (Jalas, 1993) e *Salicetalia purpureae* Moor 1958 (Wendelberger & Wendelberger, 1956; Dakskobler, 2005).

Per quanto concerne i reperti sopra elencati, il popolamento localizzato presso il Passo del Crociglia è risultato essere composto da individui con una quantità di fiori periferici stimabile in alcune decine, caratteristica tipica di piante in coltura (Pignatti, 1982). Il reperto rinvenuto nella zona di inondazione del greto del Torrente Nure è invece inserito, così come avviene nelle pianure alluvionali dell'Europa centrale (Miillerl & Okuda, 1998), in una tipica fitocenosi di piante perenni del *Convolvuletalia sepium* in cui abbondano specie aliene quali *Helianthus tuberosus* L. e *Solidago gigantea* Aiton.

Symphyotrichum novae-angliae (L.) G.L.Nesom (Asteraceae). Esotica confermata per l'Emilia-Romagna.

Reperti – PIACENZA: Ferriere, Loc. Ponte Nano, Ottobre 2003, 530 m, greto del Torrente Nure (*leg. et det.* G. Bracchi).

Specie di interesse ornamentale originaria del continente nordamericano, dove cresce in incolti umidi, incolti ruderali, margini di boschi, campi e praterie, su suoli ricchi, sabbiosi o argillosi (Strother, 2006b). È frequentemente naturalizzata in corrispondenza dei depositi fluviali e ai margini delle boscaglie ripariali di gran parte delle nazioni europee (Hitchmough & Woudstra, 1999; Wallentinus, 2002).

Da Pignatti (1982) è trattata come entità subspontanea presente solo in Veneto, dove compare nel Polesine (Benetti & Marchiori, 1992), ma più tardi è stata accertata anche per Lombardia (Aeschimann *et al.*, 2004), Trentino-Alto Adige (Prosser, 1993) e Friuli-Venezia Giulia (Costalonga, 1998). La sua effettiva acclimatazione sarebbe altresì da confermare per il Piemonte (Conti *et al.*, 2005) e la Valle d'Aosta (Aeschimann *et al.*, 2004). Relativamente all'Emilia-Romagna, la prima segnalazione si trova tuttavia in Mazzoni *et al.* (2001) e riguarda il Parco Regionale Fluviale dello Stirone (Parma) dove «[...] alcuni esemplari fioriscono regolarmente [...]» in un bosco ripariale.

Symphytum asperum Lepech. (Boraginaceae). Esotica nuova per l'Emilia-Romagna.

Reperti – PIACENZA: Farini d'Olmo, Loc. Nicelli, Maggio 2006, 1.050 m s.l.m., nel fosso ai lati della strada (*leg. et det.* E. Romani, Fig. 4).

Originaria del Caucaso e dell'Iran, un tempo coltivata come foraggera per maiali e conigli. Pare naturalizzata in alcune vallate alpine di Piemonte, Veneto e Friuli-Venezia Giulia (Pignatti, 1982; Conti *et al.*, 2005), ma anche della Spagna, della Francia, dell'Austria e della ex-Cecoslovacchia (Pyšek *et al.*, 2002; Aeschimann *et al.*, 2004). Recentemente trovata anche nelle Marche, Provincia di Macerata (Viegi *et al.*, 2003a). Possibile la confusione con la nostrana *Symphytum officinale* L. con la quale può anche generare popolazioni ibride corrispondenti al binomio *Symphytum* ×*uplandicum* Nyman.

Syringa vulgaris L. (Rosaceae). Esotica confermata per la Provincia di Piacenza.

Fig. 4 – *Symphytum asperum* Lepech., Farini d'Olmo, Loc. Nicelli, Maggio/May 2006.

Reperti – Piacenza: Ferriere, Loc. Cassimoreno, Agosto 2004, 830 m, siepi ai margini di prati da sfalcio a sud-est del paese (G. Bracchi *obs.*).

Pianta orofila originaria del sud-est europeo, è ampiamente utilizzata come ornamentale soprattutto in Europa e Nordamerica dove l'effettiva naturalizzazione pare legata soprattutto alla capacità della specie di adattarsi alle particolari condizioni climatiche riscontrabili nell'area di medi e grandi centri abitati (White *et al.*, 1993; Sukopp & Wurzel, 2003).

Secondo Pignatti (1982) coltivata e spontaneizzata sulle Prealpi dal Piemonte al Friuli, sugli Appennini in Emilia-Romagna. Da Conti *et al.* (2005, 2006) esclusa dal Trentino-Alto Adige, ma riportata come sicuramente naturalizzata anche per Marche, Umbria, Abruzzo, Molise e Sardegna, dubitativamente per Basilicata e Toscana. Per quest'ultima Regione è stata tuttavia segnalata nella recente 'Flora Pisana' di Garbari & Borzatti Von Loewenstern (2005).

Per il Piacentino già indicata da Bracciforti (1877) che tuttavia avanzava dubbi circa la sua effettiva spontaneizzazione: «[...] nei giardini ove coltivasi e nelle siepi, resa affatto spontanea [...]». Il reperto sopra indicato si riferisce a un esemplare di circa 150 cm di altezza e a una serie di esemplari più giovani osservati in fioritura per alcuni anni di seguito ai margini di una siepe in cui abbondano *Fraxinus ornus* L., *Prunus spinosa* L. e *Robinia pseudoacacia* L.

Vitis labrusca L. (Vitaceae). Esotica nuova per la Provincia di Piacenza.

Reperti – Piacenza: Farini d'Olmo, Loc. Liscato, Agosto 2003, 620 m, siepi lungo la Strada Provinciale che conduce al Passo delle Pianazze (*leg. et det.* G. Bracchi).

Pianta di origine nordamericana, ampiamente coltivata a scopo alimentare e spesso localmente nota come *uva fragola*. Secondo Pignatti (1982) è inselvatichita in tutte le Regioni, mentre Conti *et al.* (2005, 2006) escludono la naturalizzazione in Valle d'Aosta, Trentino Alto-Adige, Liguria, Lazio, Marche, Molise, Campania, Puglia, Sardegna e Lombardia. Tuttavia, relativamente alla Lombardia è considerata sia nella cartografia distributiva proposta da Aeschimann *et al.* (2004) sia nell'atlante corologico delle piante vascolari della Provincia di Cremona (Bonali *et al.*, 2006a).

Casuali

Bergenia crassifolia (L.) Fritsch (Saxifragaceae). Esotica nuova per l'Emilia-Romagna.

Reperti - PIACENZA: Ferriere, Luglio 2004, 630 m, nei vicoli tra le case (*leg. et det.* G. Bracchi); Ferriere, Loc. Cassimoreno, Luglio 2004, 830 m, base della rupe serpentinosa alle spalle della Chiesa (G. Bracchi *obs.*); Vigolzone, Loc. Carmiano, Marzo 2006, 230 m, margini del greto attivo del Torrente Nure (G. Bracchi *obs.*).

Pianta erbacea perenne originaria del continente asiatico, diffusa in foreste e lungo rupi rocciose ombreggiate tra 1.000 e 2.000 m s.l.m. di Xinjiang (Cina), Corea del Nord, Mongolia settentrionale e Russia centro-orientale (Jintang & Soltis, 2001).

Largamente impiegata come ornamentale da vaso o da giardino, non compare tra le esotiche naturalizzate nella *checklist* di Conti *et al.* (2005). Ciò, nonostante Aeschimann *et al.* (2004) e Viegi *et al.* (2003a) abbiano indicato popolazioni spontaneizzate in Lombardia (Provincie di Sondrio e Como) e Marche (Provincie di Ancona, Ascoli Piceno, Macerata e Pesaro) rispettivamente.

Callistephus chinensis (L.) Nees (Asteraceae). Esotica confermata per l'Emilia-Romagna.

Reperti – PIACENZA: Ferriere, Loc. Ponte Nano, Settembre 2003, 530 m, nel greto del Torrente Nure (*leg. et det.* G. Bracchi & E. Banfi).

Specie originaria della Cina, dove vegeta in praterie, lungo corsi d'acqua e in foreste aperte fino a 2.700 m s.l.m., generalmente in luoghi ombreggiati (Yilin *et al.*, in prep.).

Erroneamente indicata da Pignatti (1982) e da Conti *et al.* (2005) *sub Callistephus 'sinensis'* (L.) Nees.

Frequentemente coltivata per ornamento, è già stata segnalata come subspontanea per Lombardia, Alto Adige, Veneto (Viegi *et al.*, 1973; Pignatti, 1982) e Friuli-Venezia Giulia (Poldini *et al.*, 2001) ma in Conti *et al.* (2005) è riportata solo per quest'ultima Regione. Esiste anche una vecchia segnalazione per l'Emilia (Pavesi, 1919), lungo il Trebbia in pianura (Piacenza), ma qui non è più stata ritrovata.

Naturalizzata anche in Svizzera (Aeschimann & Heitz, 2005), Austria (Essl & Rabitsch, 2004), Francia (Lonechamp, 1999) e Repubblica Ceca (Pyšek *et al.*, 2002).

Trattasi di pianta annuale la cui eventuale diffusione potrebbe essere relazionata a impatti economici di varia portata, in quanto è tra le ornamentali ospiti del *tomato spotted wilt virus* (TSWV) del genere *Tospovirus*, da noi noto come virus della bronzatura o dell'avvizzimento maculato del pomodoro (*Solanum lycopersicum* L.). In realtà tale fitopatologia colpisce anche colture di insalate (*Lactuca sativa* L.), peperoni (*Capsicum annuum* L.), melanzane (*Solanum melongena* L.), patate (*Solanum tuberosum* L.), cipolle (*Allium cepa* L.) e altri ortaggi, arrivando a determinare la perdita di interi raccolti (Chatzivassiliou *et al.*, 2000; Gallitelli & Davino, 1998). Contrariamente alle specie coltivate, le piante selvatiche interessate da infezioni di *Tospovirus* mostrano solo pochi sintomi o ne sono totalmente prive (Chatzivassiliou *et al.*, 2001).

Caryopteris ×clandonensis hort. ex Rehd. (Verbenaceae). Esotica nuova per l'Emilia-Romagna.

Reperti – PIACENZA: San Giorgio Piacentino, Ottobre 2007, 140 m, nel greto consolidato del Torrente Nure a monte del paese (*leg. et det.* E. Romani).

Ibrido culturale (*C. incana* (Thunb. ex Houtt.) Miq. ×*C. mongholica* Bunge) diffusamente utilizzato come ornamentale in parchi e giardini. Nella stazione cui fa riferimento il reperto sopra illustrato è stato rinvenuto un unico esemplare in condizioni di ambiente semiruderale, forse derivante da scarti di potatura che effettivamente sono stati osservati in zona.

Koelreuteria paniculata Laxm. (Sapindaceae). Esotica nuova per la Provincia di Piacenza.

Reperti – PIACENZA: Monticelli d'Ongina, Loc. San Nazzaro, Settembre 2006, 40 m, lungo la massicciata della difesa spondale (*leg. et det.* E. Romani, Fig. 5).

Piccolo albero o arbusto endemico delle foreste della Cina dove è anche diffusamente utilizzato per ornamento e legno (Nianhe & Gadek, 2000). In Europa raramente coltivato in giardini e parchi. Secondo Pignatti (1982) si tratta di specie già segnalata come inselvatichita in Romagna, ma non compare nella né in 'Flora Euorpaea' (Tutin *et al.*, 1964-1980) né nella recente *checklist* della flora d'Italia (Conti *et al.*, 2005). E' tuttavia citata come «[...] talvolta inselvatichita [...]» nell'atlante corologico delle piante vascolari della Provincia di Cremona (Bonali
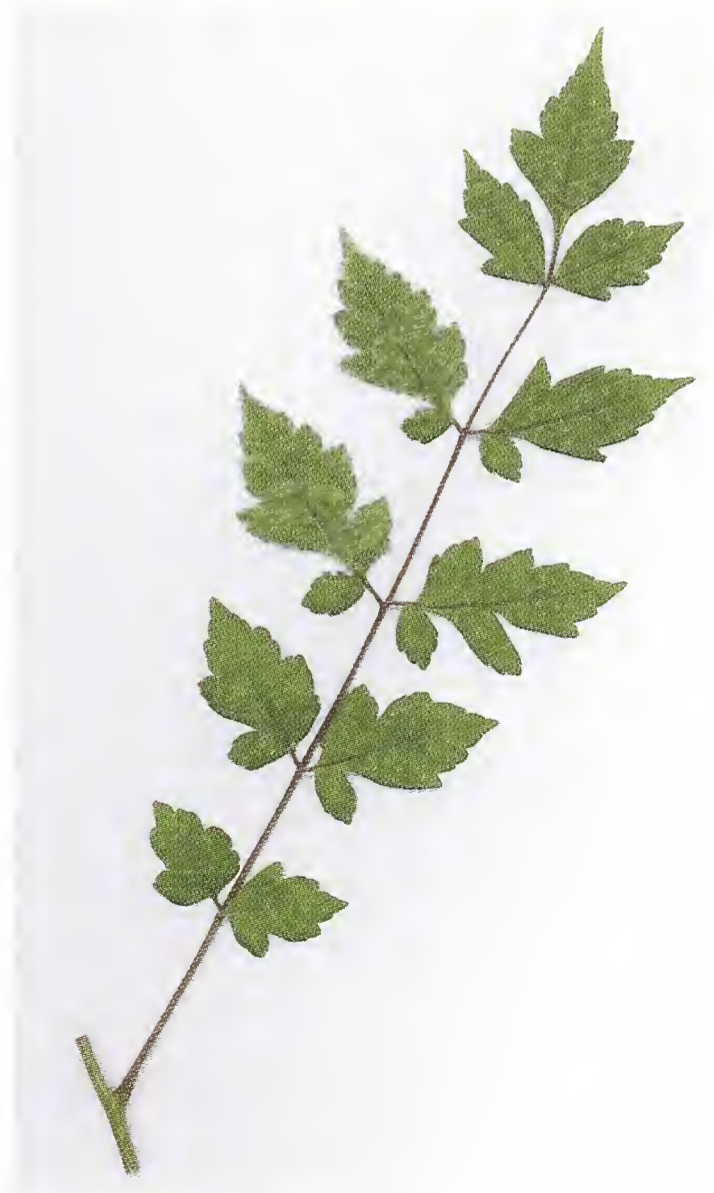
Fig. 5 – *Koelreuteria paniculata* Laxm., Monticelli d'Ongina, Loc. S. Nazzaro, Agosto/August 2004.

et al., 2006a). Da rilevare come nella quasi totalità delle flore il genere cui fa riferimento la pianta in oggetto sia erroneamente citato come "*Kohlreuteria*" invece di *Koelreuteria* Laxm. [*Novi Comment. Acad. Sci. Imp. Petrop.* 16: 1772].

Presso la stazione cui si riferisce il reperto sopra illustrato, sono presenti diversi esemplari talvolta ridotti a corti ricacci su fusti legnosi appressati al suolo, probabilmente a causa dello sfalcio regolare a cui è soggetta la massicciata. Sembra tuttavia diffondersi facilmente per talee di radici o di fusto seppur pare resistere poco ai freddi intensi. Con tutta probabilità gli esemplari in oggetto traggono origine da alcuni soggetti coltivati nei giardini pubblici adiacenti alla sponda del Po.

Oenothera chicaginensis de Vries ex Renner & Cleland (Onagraceae). Esotica nuova per l'Emilia-Romagna.

Reperti – PIACENZA: Ferriere, Loc. Noce di Brugneto, Ottobre 2003, 900 m, prati vicino alle case (*leg. et det.* G. Bracchi).

Pianta bienne di origine nordamericana per la prima volta introdotta in Europa (Austria) nel 1917 e gradualmente diffusasi soprattutto nei paesi della parte centro-meridionale e centro-orientale del continente (Mihulka & Pyšek, 2001). In Italia nota per Lombardia, Veneto e Toscana marittima, ma sempre per stazioni localizzate ad altitudini inferiori rispetto a quella considerata (Soldano, 1992). L'areale di questa entità non sembra tuttavia aver subito una naturale espansione altitudinale: il presente reperto è infatti ragionevolmente da considerarsi quale frutto di introduzione recente a scopo ornamentale e non relazionato con la naturale espansione che ha interessato le popolazioni europee di *Oenothera* negli ultimi decenni (Mihulka & Pyšek, 2001).

Oxalis purpurata Jacq. (Oxalidaceae). Esotica nuova per l'Emilia-Romagna.

Reperti – PIACENZA: Gazzola, Loc. Bosco di Croara, Aprile 2007, 150 m, lungo la strada di accesso al Bosco (*leg. et det.* E. Romani, Fig. 6).

Originaria dell'Africa meridionale, fa parte del gruppo di *Oxalis* L. comunemente coltivate. In Italia è nota come naturalizzata in Veneto, Liguria, Toscana, Abruzzo e Sicilia (Conti *et al.*, 2005). La sua presenza nel territorio Piacentino è forse da considerarsi solo effimera.

Phyllostachys edulis (Carrière) Houz. (Poaceae). Esotica nuova per l'Emilia-Romagna.

Reperti – PIACENZA: Coli, Loc. Pontè, Febbraio 2006, 450 m, in ambiente rupestre ofiolitico lungo la strada per Loc. Forno (*leg. et det.* E. Romani).

Le specie del genere *Phyllostachys* Sieb. & Zucc. (bambù) sono piante originarie dell'Asia centro-orientale, in tutto il mondo diffusamente coltivate nei giardini e talvolta abbandonate presso le abitazioni. In pochi casi però appaiono come veramente naturalizzate anche perché solitamente diffondono solo per via vegetativa.

In Cina, paese di origine dove cresce lungo i versanti montani fino a 1.600 m di altitudine, *P. edulis* è senza dubbio la specie di bambù economicamente più importante, largamente coltivata in virtù dell'elasticità e versatilità dei culmi e per i deliziosi germogli (Zhengping & Stapleton, 2006).

Da Conti *et al.* (2005) la naturalizzazione in Italia di *P. edulis* è ammessa solo per Veneto e Friuli-Venezia Giulia. Nel Piacentino sono coltivate anche *P. bambusoides* Sieb. & Zucc., *P. mitis* Rivière & C.Riviére, P. *nigra* (Lodd. ex Lindl.) Munro e *P. viridiglaucescens* (Carrière) Rivière & C.Riviére (Banfi *et al.*, 2005).

Il reperto sopra illustrato si riferisce tuttavia a una stazione distante da abitazioni e già osservata diversi anni fa (1996) con pochi individui di ridotte dimensioni (1–1,5 m).

Fig. 6 – *Oxalis purpurata* Jacq., Gazzola, Loc. Bosco di Croara, Aprile/April 2007.

Rudbeckia hirta L. var. ***hirta*** (Asteraceae). Esotica nuova per l'Emilia-Romagna.

Reperti – PARMA: Bardi, Loc. Santa Giustina, Agosto 2004, 810 m, margini dei campi presso le case (*leg. et det.* G. Bracchi).

Specie nordamericana coltivata in numerose varietà che, particolarmente in Europa centro-orientale, hanno talora generato popolamenti subspontanei, soprattutto nei pressi dei centri abitati, ma anche lungo le ripe dei fiumi e ai margini di boschi e coltivi (Hansen, 1976). Il popolamento cui si riferisce il reperto sopra illustrato, localizzato nella media Val Taro (Val Lecca), presenta i caratteri diagnostici della var. *hirta* (= *R. brittonii* Small), originaria degli Stati Uniti orientali (dagli Appalachi all'Illinois) e con foglie da ellittiche a ovali lunghe da 2,5 a 7 cm, diversamente dalla var. *pulcherrima* Farwell (= *R. bicolor* Nutt., *R. serotina* Nutt., *R. strigosa* Nutt.), diffusa in tutti gli Stati Uniti e dotata di foglie strettamente ellittiche lunghe da 1 a 2,5 cm (Urbatsch & Cox, 2006).

In merito alla valutazione della diffusione e dello status di *R. hirta* in relazione alla flora esotica d'Italia, pare significativo il risultato del confronto tra i dati distributivi proposti in 'Flora d'Italia' di Pignatti (1982) e quelli redatti da Conti *et al.* (2005, 2007) nella più recente *checklist*. In particolare, nella prima l'autore afferma «Non segnalata in It., ma in espansione in tutta Europa: da ricercare.», mentre nella *checklist* appare come esotica naturalizzata in Lombardia (Aeschimann *et al.*, 2004), Veneto (Lasen, 1983) e Friuli-Venezia Giulia (Poldini *et al.*, 2001), sempre in ambito alpino. Da Soldano (2000) trovata anche in Valle d'Aosta lungo la sponda di un torrente.

Tagetes erecta L. (Asteraceae). Esotica nuova per l'Emilia-Romagna.

Reperti – PIACENZA: Ferriere, Loc. Ponte Nano, Settembre 2003, 530 m, greto del Torrente Nure (*leg. et det.* G. Bracchi).

Molte piante afferenti al genere nord-, centro- e sudamericano *Tagetes* L. sono di frequente utilizzo ornamentale oltre che fitosanitario grazie agli sgargianti colori delle corolle da una parte, alla capacità di produrre tiofeni nematicidi a livello dei tessuti radicali dall'altra (Uhlenbroek & Bijloo, 1958, 1959).

Oltre alla specie qui trattata, originaria del Messico e degli Stati Uniti meridionali e commercializzata in numerosi cultivar in fiori recisi, in Italia sono coltivate e talora naturalizzate anche la nordamericana *T. minuta* L. (Soldano, 2000) e la messicana *T. patula* L. (Conti *et al.*, 2005), quest'ultima da alcuni sinonimizzata con la stessa *T. erecta* nonostante gli involucri più piccoli e la corolla totalmente o parzialmente screziata di marrone (Strother, 2006b).

In Italia, *T. erecta* è nota come esotica casuale solo per il Friuli-Venezia Giulia (Poldini *et al.*, 2001).

Analogamente a quanto già osservato per *Callistephus*, anche *Tagetes* può costituire serbatoio di *Tospovirus*, contribuendo quindi a determinare eventuali danni economici a talune tipologie colturali (Chatzivassiliou *et al.*, 2000).

Tamarix parviflora DC. (Tamaricaceae). Esotica nuova per l'Emilia-Romagna.

Reperti – PIACENZA: San Giorgio Piacentino, Loc. San Damiano, Aprile 2007, 140 m, nel greto consolidato del Torrente Nure, in ambiente semiruderale (*leg. et det.* E. Romani, Fig. 7).

Specie originaria della regione egea e della penisola balcanica, in Conti *et al.* (2005) viene considerata naturalizzata per Lazio, Sicilia e Sardegna. Esistono tuttavia segnalazioni anche per il Piemonte (Ebone & Spaziani, 2001) e per le siepi della fascia litoranea delle Marche (Viegi *et al.*, 2003a).

Allo stato attuale la sua presenza in Emilia-Romagna sembra essere tuttavia limitata a pochi ed isolati esemplari in condizioni di ambiente semiruderale, forse

Fig. 7 – *Tamarix parviflora* DC., San Giorgio Piacentino, Loc. S. Damiano, Aprile/April 2007.

derivanti da scarti di potatura che effettivamente sono stati osservati nella zona cui si riferisce il reperto considerato.

Alcuni studi svolti negli Stati Uniti hanno dimostrato come la diffusione di *T. parviflora* lungo i greti fluviali sia in grado di produrre la graduale riduzione delle comunità di piante native in termini di biodiversità, alterare la morfologia delle vie d'acqua, assorbire notevoli quantità delle riserve d'acqua disponibili, incrementare la frequenza di incendi, ridurre l'utenza ricreativa e agroculturale e in alcuni casi addirittura contribuire al declino di alcune popolazioni di pesci (Busby & Schuster, 1971; Graf, 1978).

Discussione e conclusioni

Sono segnalate 5 specie nuove e 3 specie confermate rispetto alla flora esotica d'Italia naturalizzata in Provincia di Piacenza (Romani & Alessandrini, 2001; Bracchi *et al.*, 2003; Gallo & Bracchi, 2005): *Alcea biennis* subsp. *biennis*, *Lemna minuta*, *Lepidium didymum*, *Oxalis dillenii* e *Vitis labrusca* le nuove; *Broussonetia papyrifera, Syringa vulgaris* e *Hemerocallis fulva* le confermate.

Sono segnalate 7 specie nuove e 2 specie confermate rispetto alla *checklist* della flora esotica d'Italia naturalizzata in Emilia-Romagna (Conti *et al.*, 2005, 2006): *Coreopsis lanceolata*, *Crepis dioscoridis*, *Egeria densa*, *Erigeron strigosus*, *Heracleum mantegazzianum*, *Najas gracillima* e *Symphytum asperum* le nuove, *Rudbeckia laciniata* var. *laciniata* e *Symphyotrichum novae-angliae* le confermate.

È segnalata una specie confermata rispetto alla *checklist* della flora esotica naturalizzata in Italia (Conti *et al.*, 2005, 2006): *Crepis dioscoridis.*

Si rende inoltre noto che la possibilità di naturalizzazione in Emilia-Romagna di popolamenti di *Bergenia crassifolia*, *Callistephus sinensis*, *Caryopteris* ×*clandonensis, Koelreuteria paniculata*, *Oenothera chicaginensis*, *Oxalis purpurata*, *Phyllostachys edulis*, *Rudbeckia hirta* var. *hirta*, *Tagetes erecta* e *Tamarix parviflora* merita di essere verificata e monitorata alla luce dei reperti qui discussi e collezionati nella porzione occidentale della regione.

Si sottolinea infine che secondo le osservazioni raccolte e illustrate dagli scriventi meriterebbero di essere applicate, per le ragioni conservazionistiche, economiche e socio-sanitarie di seguito illustrate, indagini mirate all'eventuale messa in pratica di misure di contenimento soprattutto di:

Egeria densa, *Lemna minuta, Najas gracillima*: specie appartenti a famiglie che annoverano le più invasive piante a livello mondiale, sia in termini di gravità di effetti provocati sia in termini di diffusione (Daehler, 1998). In questo senso, soprattutto per *Egeria densa* (Batianoff & Butler, 2002; Zimmermann, 2003; Mehrhoff, 2005; Bonali *et al.*, 2006a) e ancor di più per *Lemna minuta* (Weber, 1999; Brunel & Tison, 2005; Bonali *et al.*, 2006a) sono stati talvolta registrati alti livelli di invasività. Tutte appaiono tuttavia in espansione negli habitat acquatici planiziali padani. In particolare, gli autori del presente contributo hanno potuto osservare come il comportamento invasivo si esplichi in acque perennemente ricambiate per le prime, stagnanti per la terza, spesso a discapito di comunità di idrofite autoctone già fortemente depauperate per le cause più diverse.

Callistephus chinenis, Tagetes erecta: specie la cui eventuale diffusione merita di essere monitorata in relazione al fatto che possono frequentemente (percentuale di incidenza 30-40%) rappresentare piante-serbatoio di alcuni *Tospovirus* in grado di produrre danni economici anche rilevanti a certuni tipi di coltivazione tra cui

quella del pomodoro, sia in termini diretti sia implicando precauzioni fitosanitarie (Chatzivassiliou *et al.*, 2000).

Heracleum mantegazzianum: analogamente alla più nota e diffusa *Ambrosia* spp. trattasi di pianta la cui espansione potrebbe implicare la relativa diffusione di problematiche allergeniche di varia natura (Derraik, 2007), senza contare le già citate implicazioni negative legate all'invasività nei contesti ripariali.

Coreopsis lanceolata, Rudbeckia laciniata, Tamarix parviflora: come anche la precedente, la loro diffusione merita di essere monitorata soprattutto negli ambienti di conoide dei torrenti appenninici e lungo il Po dove con il tempo potrebbero rivelarsi invadenti producendo la graduale riduzione delle comunità di piante native in termini di biodiversità.

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Upogebia miocenica n. sp. (Crustacea, Thalassinidea, Upogebiidae) from the Miocene of Catalonia (Spain)

Abstract – *Upogebia miocenica* n. sp. (Upogebiidae Borradaile, 1903) is described from the Miocene around Vilafranca del Penedès (Barcelona). The discovery of *U. miocenica* n. sp. enhances the knowledge of the genus because not only it is the most complete species known then in Europe, but it enlarges the palaeogeographic distribution of the genus, known to date only in Hungary and Italy.

Key words: Crustacea, Thalassinidea, Miocene, Spain.

Resumen – *Upogebia miocenica* n. sp. (Crustacea, Thalassinidea, Upogebiidae) del Mioceno de Cataluña (España).

Se describe un nuevo taxón de crustáceo talassínido del Mioceno, recuperado de la población de Vilafranca del Penedès (Barcelona). Los especímenes estudiados se asignan a la infraorden Thalassinidea Latreille, 1831 con el registro de *Upogebia miocenica* n. sp. (Upogebiidae Borradaile, 1903). El hallazgo de *U. miocenica* n. sp. es destacable no tan sólo por ser la especie más completa conservada en Europa, sino porque amplía la distribución paleogeográfica del género, conocido hasta el momento en Hungría e Italia.

Palabras clave: Crustacea, Thalassinidea, Mioceno, España.

Riassunto – *Upogebia miocenica* n. sp. (Crustácea, Thalassinidea, Upogebiidae) del Miocene della Catalonia (Spagna).

Upogebia miocenica n. sp. (Upogebiidae Borradaile, 1903) è descritta nel Miocene dei dintorni di Vilafranca del Penedès (Barcellona). La scoperta di *U. miocenica* n. sp. incrementa le conoscenze del genere non solo perché si tratta della specie più completa finora conosciuta in Europa, ma anche perché allarga la distribuzione paleogeografica del genere, conosciuto finora solo in Ungheria e Italia.

Parole chiave: Crustacea, Thalassinidea, Miocene, Spagna.

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Introduction and geological setting

Recent works for a construction in the district named Les Clotes, of the Vilafranca del Penedès City (Province of Barcelona, Catalonia) (Fig. 1), allowed to rescue abundant and extraordinarily complete thalassinoids assigned here to the genus *Upogebia* Leach, 1814. The subsoil of the city of Vilafranca del Penedès is geologically situated within the Vallès-Penedès basin, mainly filled by non-marine alluvial sequences interrupted by at least three episodes of marine transgressions (Cabrera *et al.,* 1991; Cabrera & Calvet, 1996). The sediments containing crustaceans at this locality correspond to the Langhian transgression (Middle Miocene), which is supposed to be the most extensive, and is characterized locally by yellow and gray clays widely distributed along the Basin (Batllori & García, 1997; Sanz, 2001; Gibert & Robles, 2005). The local associated fauna consists of small and not abundant bivalves and gastropods scarcely distributed within gray clays, in contrast to the macrurans that are very abundant considering the reduced surface of collection. The Vallès-Penedès basin extends in a southwest-northeast direction, nearly parallel to the present coast, and during the Langhian transgression the subsoil of Vilafranca del Penedès was approximately situated in the central area, so that the local deposits correspond to a fairly marine facies. Some previous records have been established for crustaceans within the area and similar age, supposed to be characteristic of concrete environmental conditions as reefal or nearshore habitats (Müller, 1993; Artal, 2007); the new taxon, according to the lithology, associated fauna, and location within the basin appears to be characteristic of open but shallow marine environmental conditions.

Previous reports of Miocene upogebids from Spain

The specimens of upogebids from the Miocene of Spain are rare and limited today only to one report. Müller (1993) reported some complete but poorly preserved, piritized specimens from Vilafranca (Barcelona), ascribing them to *Upogebia* sp., pointing out that even though the specimens are entirely preserved, fine details were obscured not permitting a closer determination.
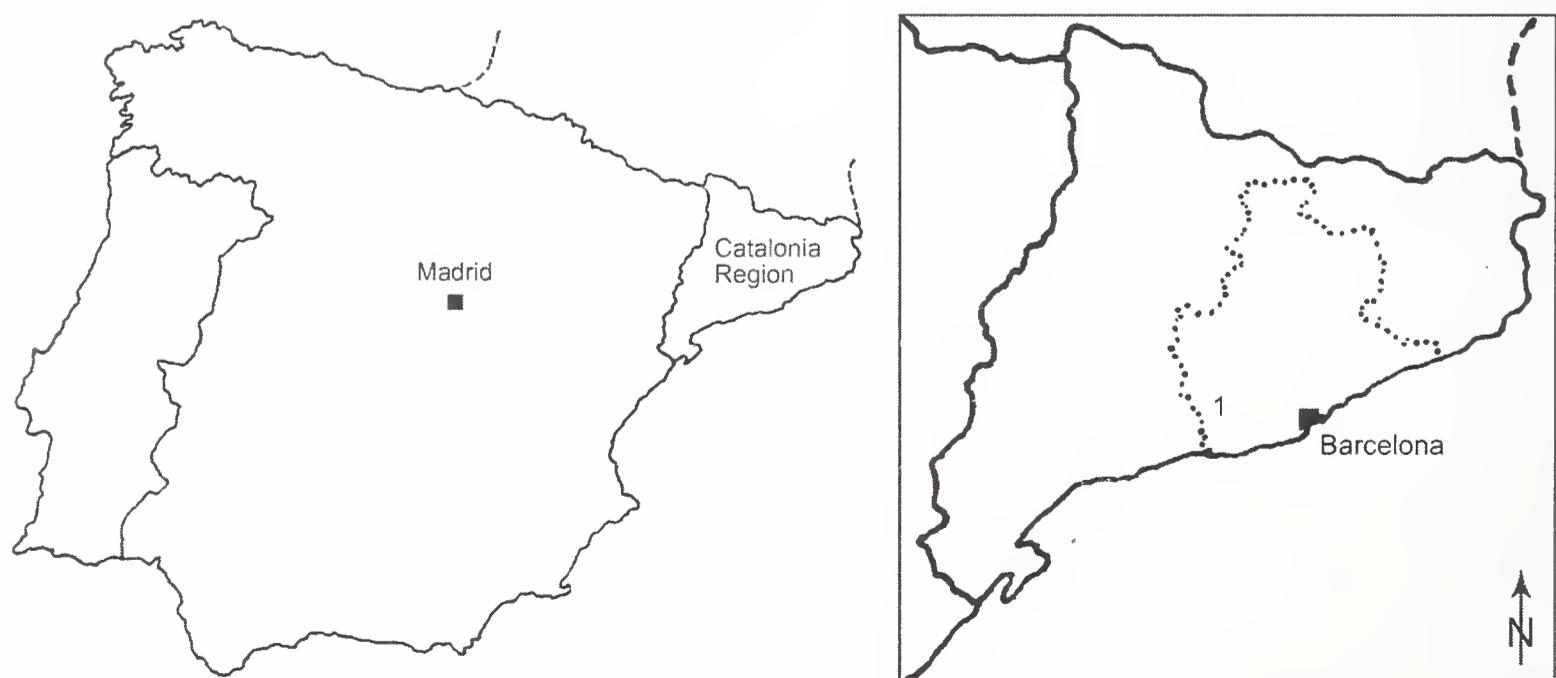
Fig. 1 – Geographic map with the fossiliferous locality / cartina geografica con la località fossilifera. 1) Vilafranca del Penedès.

However the review of these specimens and the new collected material subject of this study, allowed to identify many morphological characters useful for their correct determination and reconstruction of the belonging species.

Material

The studied sample includes eleven fragmentary and articulate specimens, housed in the Museu Geològic del Seminari Conciliar of Barcelona (MGSB). The specimens are flatted on the bedding planes. Their preparation was easy as a result of the softness of the surrounding clay. The studied specimens are ascribed to *Upogebia miocenica* n. sp.

The systematic arrangement used in this paper follows the recent classification proposed by Tsang *et al.* (2008).

Abbreviations

P1-P5, first to fifth pereiopods; a1-a6, abdominal segments; mpx3, third maxilliped.

Measurements are given in millimetres (mm).

Systematic Palaeontology

Infraorder Thalassinidea Latreille, 1831
Superfamily Thalassinoidea Latreille, 1831
Family Upogebiidae Borradaile, 1903
Genus *Upogebia* Leach, 1814

Type species: *Cancer* (*Astacus*) *stellatus* Montagu, 1808, by original designation.

Included fossil species: *U. barti* Fraaije, Van Bakel, Jagt & Coole, 2006; *U. boehmi* Glaessner, 1930; *U. dura* (Moericke, 1889); *U. eocenica* Rathbun, 1926; *U. gamma* (Rathbun, 1935); *U. lambrechtsi* Fraaije, Van Bakel, Jagt & Coole, 2006; *U. midwayensis* Rathbun, 1935; *U. mizunamiensis* Karasawa, 1989; *U. perarolensis* De Angeli & Messina, 1992; *U. rhacheochir* (Stenzel, 1945); *U. scabra* Müller, 1974; *U. striata* Karasawa & Kishimoto, 1996; *U. tanegashimensis* Karasawa & Inoue, 1992.

Upogebia miocenica n. sp.
Figs. 2-8

Diagnosis: carapace elongate, wide; anterior dorsal margin serrate; rostrum short, spineless and curved downwards; cervical groove weak; P1 subchelate with dactylus having two rows of strong parallel tubercles running along dorsal margin; P2-5 achelate.

Etymology: the trivial name alludes to Miocene, geological period of the studied specimens.

Holotype: MGSB 74532 a-b (part and counter-part).
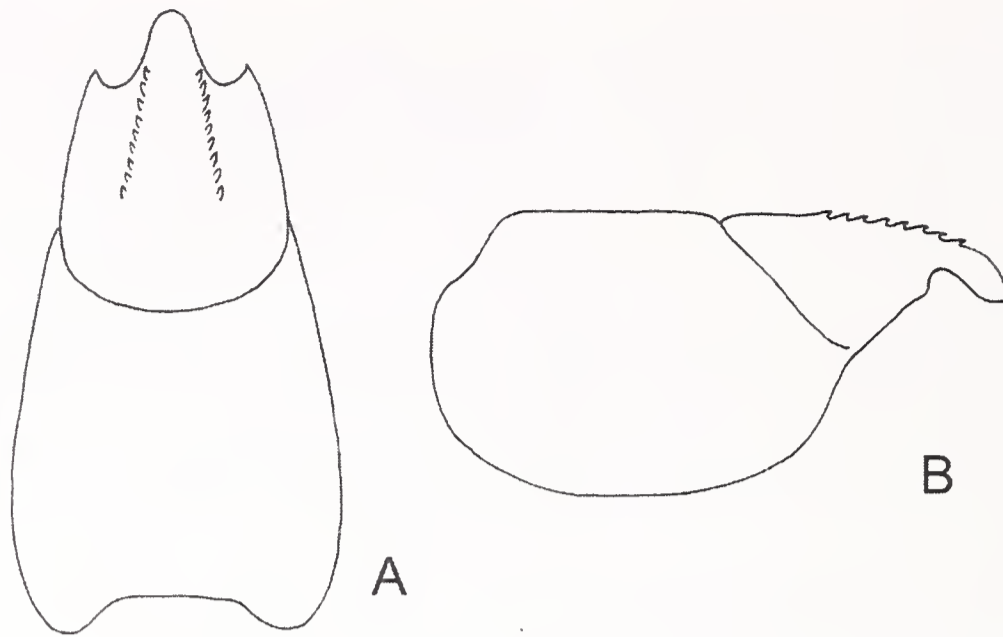
Fig. 2 – *Upogebia miocenica* n. sp. A) dorsal view of carapace / norma dorsale del carapace. B) lateral view of carapace / norma laterale del carapace.
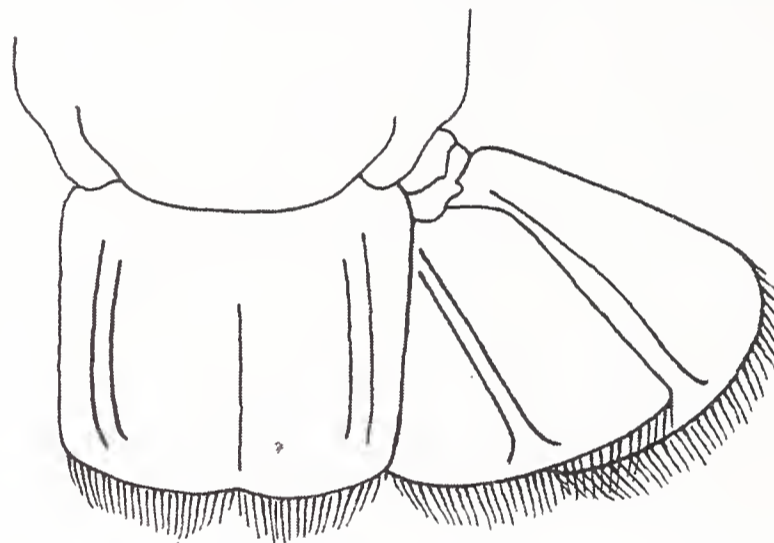
Fig. 3 – *Upogebia miocenica* n. sp., tail fan / ventaglio caudale.

Fig. 4 – *Upogebia miocenica* n. sp., incomplete reconstruction / ricostruzione incompleta.

Paratypes: MGSB 74533 a, 74534 b.

Type locality: Vilafranca del Penedès (Barcelona, Catalonia).

Geological age: Miocene.

Material: eleven fragmentary and articulate specimens in lateral and dorsal view, 40-50 mm long. MGSB 74532 a-b (part and counter-part), 74533 a, b, c, 74534 a-b (part and counter-part), c, 74535 a, b, c, d, e.

Fig. 5 – *Upogebia miocenica* n. sp., MGSB 74532, holotype / olotipo (x 2).
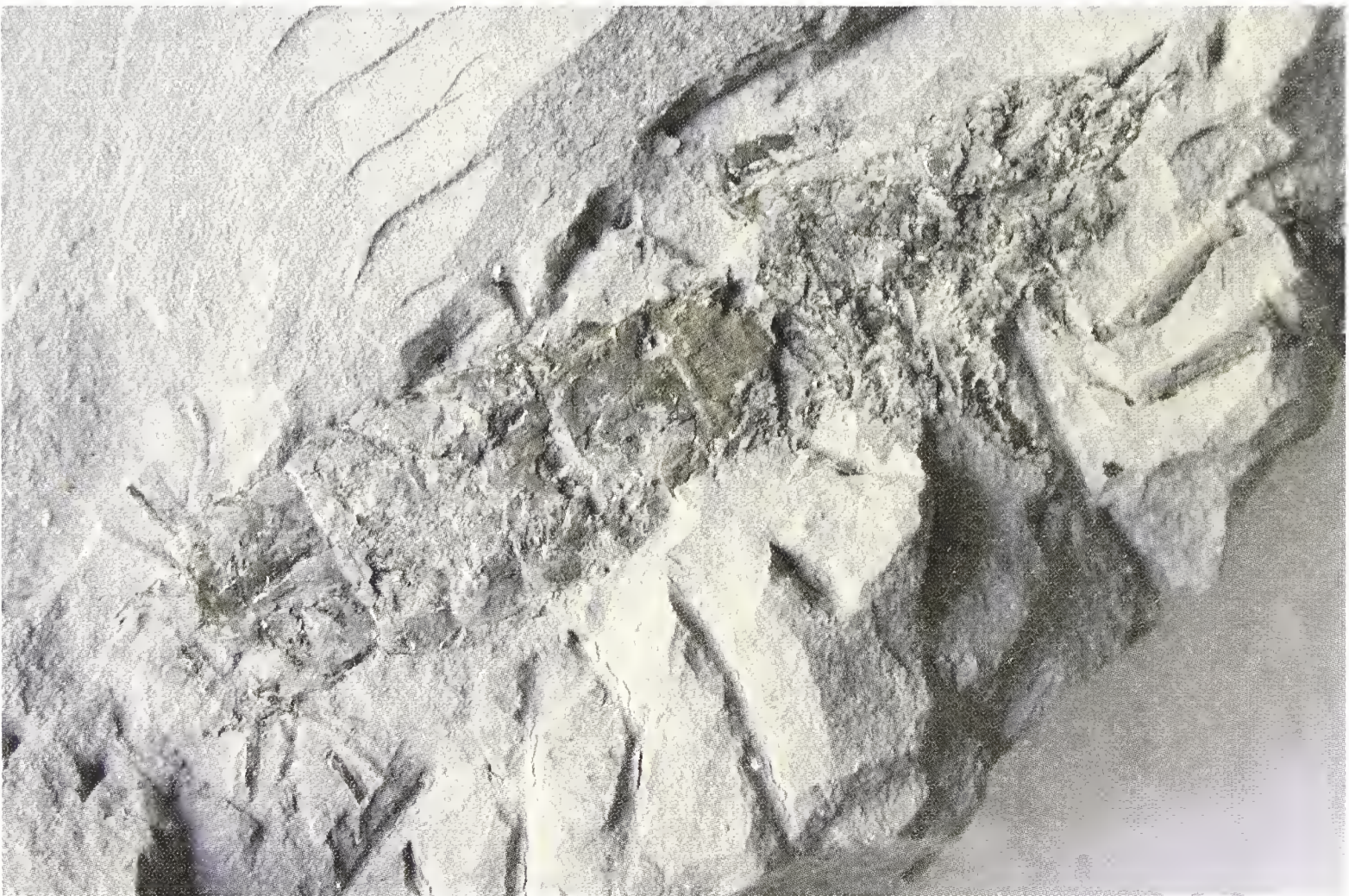
Fig. 6 – *Upogebia miocenica* n. sp., MGSB 74534 b, paratype / paratipo (x 2).

Description: medium-sized upogebid with exoskeleton finely tuberculate.

Carapace. Carapace elongate, wide. Anterior dorsal margin serrate. Rostrum short, spineless, strongly curved downwards. Cervical groove weak, complete. Gastric region narrow, smooth. Cardiac and branchial regions wide, smooth.

Abdomen. Segments a1, 3-5 equal in size. Segment a2 longer than the others. Segment a6 longer than a5. Telson subquadrate with lateral margins slightly converging backwards. Dorsal surface of telson with a weak median groove and a pair of strong ridges running parallel to lateral margins. Endopod of uropod reaching level of posterior margin of telson. Endopod of uropod with posterior margin slightly concave, straight outer margin, and strong median ridge. Exopod of uropod slightly overreaching endopod. Exopod of uropod with strong median ridge.

Cephalic appendages. Not well preserved. Only the specimen MGSB 74535d preserved long flagellum of antennae.

Thoracic appendages. mpx3 not preserved. P1 subchelate. Merus bearing two subterminal spines on dorsal margin, ventral margin spineless. Carpus bearing a median spine on dorsal margin, ventral margin spineless. Propodus bearing two proximal spines on
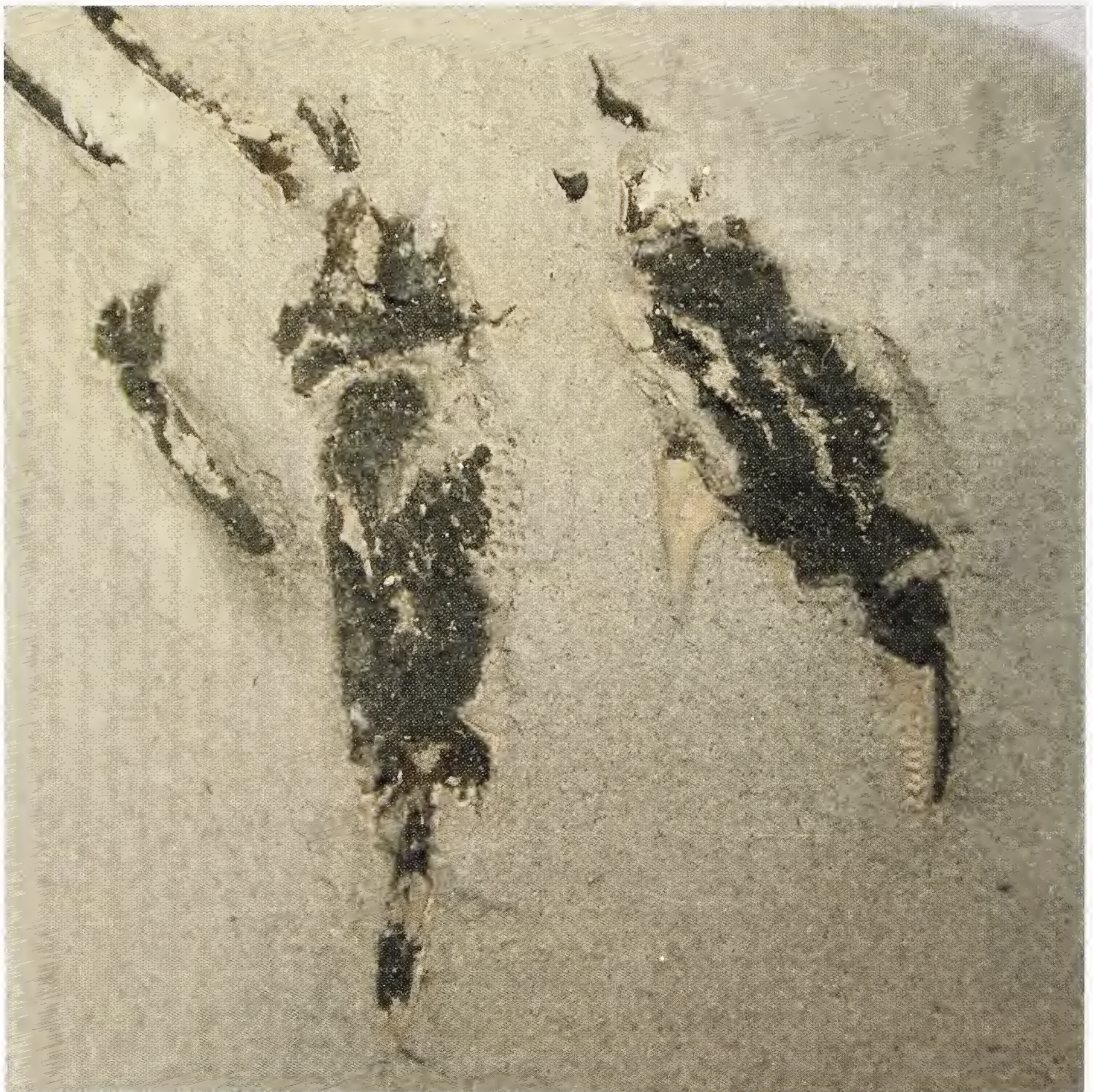
Fig. 7 – *Upogebia miocenica* n . sp., MGSB 74534b, detail of P1 / dettaglio di P1 (x 2).

Fig. 8 – *Upogebia miocenica* n . sp., MGSB 74535, detail of tail fan / dettaglio del ventaglio caudale (x 2).

dorsal margin, ventral margin with one strong, stout distal tooth. Dactylus strong, stout. Dorsal surface of dactylus having two rows of strong parallel tubercles running along dorsal margin. A series of small tubercles covering tip of dactylus. P2-5 achelate.

Abdominal appendages. Not preserved.

Discussion. As reported by Ngoc-Ho (2003), *Upogebia* is characterized by possession of cervical groove well defined, rostrum obtuse, bearing teeth or spines on lateral border, rarely unarmed, telson often with faint inverted U-shaped ridge dorsally, posterior border straight or slightly convex, unarmed, P1 equal, chelate or subchelate, P2-4 achelate, P5 subchelate, no suture on uropods. Most of these morphological characters are visible on the studied specimens that are ascribed to this genus.

At present, Upogebiidae has almost exclusively represented by Cenozoic species: *U. eocenica* Rathbun, 1926, *U. gamma* (Rathbun, 1935), and *U. midwayensis* Rathbun, 1935 (Eocene, United States), *U. barti* Fraaije, Van Bakel, Jagt & Coole, 2006 (Oligocene, United States), and *U. lambrechtsi* Fraaije, Van Bakel, Jagt & Coole, 2006 (Eocene, Belgium), *U. perarolensis* De Angeli & Messina, 1992 (Oligocene, Italy), *U. scabra* Müller, 1974 (Miocene, Hungary), *U. mizunamiensis* Karasawa, 1989, *U. striata* Karasawa & Kishimoto, 1996, and *U. tanegashimensis* Karasawa & Inoue, 1992 (Miocene, Japan).

Among the above-mentioned species, *U. scabra* is the only European species known to date from the middle Miocene (Badenian), represented by just one badly preserved carapace in dorsal view (Müller, 1974). Later Müller (1984) included this species among the synonymies of *Upogebia* sp. (div.?). Even though the comparison between the two Miocene species is difficult, *U. miocenica* n. sp. differs from the Hungarian species having a serrate anterior dorsal margin of the carapace and a short rostrum that is spineless strongly curved downwards.

Upogebia miocenica n. sp. is the most complete species of this genus known to date in Europe and its discovery enlarges the palaeogeographic distribution of *Upogebia*, known to date only in Hungary and Italy.

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Alessandro Garassino*, Pedro Artal** & Giovanni Pasini***

Jaxea nocturna Nardo, 1847 (Crustacea, Thalassinidea, Laomediidae) from the Pliocene of Catalonia (Spain)

Abstract - *Jaxea nocturna* Nardo, 1847 (Laomediidae Borradaile, 1903) is reported from the Pliocene of Papiol (Barcelona). The report of *J. nocturna* in Spain enhances the knowledge of the genus because not only it is the most complete fossil species known then in Europe, but it enlarges the palaeogeographic distribution of the genus, known to date only in Italy and Hungary.

Key words: Crustacea, Thalassinidea, Pliocene, Spain.

Resumen - *Jaxea nocturna* Nardo, 1847 (Crustacea, Thalassinidea, Laomediidae) del Plioceno inferior de Cataluña (España).

Se describe un conjunto de crustáceos talassinidos recuperados en las cercanías de la localidad del Papiol (Barcelona). Los ejemplares estudiados se ascriben a la infraorden Thalassinidea Latreille, 1831 y se asignan a la especie *Jaxea nocturna* Nardo, 1847 (Laomediidae Borradaile, 1903). La confirmación de *J. nocturna* es notable no tan solo por representar la especie fósil más completa hasta ahora conocida en Europa, sino por ampliar la distribución paleogeográfica del género, conocido hasta el momento tan sólo en Italia y Hungría.

Palabras clave: Crustacea, Thalassinidea, Plioceno, España.

Riassunto - *Jaxea nocturna* Nardo, 1847 (Crustácea, Thalassinidea, Laomediidae) del Pliocene inferiore della Catalonia (Spagna).

Jaxea nocturna Nardo, 1847 (Laomediidae Borradaile, 1903) è segnalata nel Pliocene di Papiol (Barcellona). La scoperta di *J. nocturna* in Spagna incrementa le conoscenze del genere in quanto si tratta della specie più completa finora conosciuta in Europa, allargando inoltre la distribuzione plaeogeografica del genere, conosciuto finora solo in Italia e Ungheria.

Parole chiave: Crustacea, Thalassinidea, Pliocene, Spagna.

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Introduction and geological setting

The marine sediments yielding crustaceans around the village of Papiol (Fig. 1) were firstly described during the nineteenth century, being yet assigned as Pliocene in age (Almera, 1894). The layers, rather homogeneous and of a decametric thickness, consist of blue and yellow clays widely distributed along the Baix Llobregat basin. The study of the abundant and diverse macrofauna, mainly represented by gastropods, bivalves and leaves, has resulted in numerous publications (Almera, 1894; Sanz, 1983; Solsona, 1999), confirming the infilling of the basin during the Zanclean marine transgression. After the Messinian regression, the valley of the river Llobregat was deeply eroded, as much basins along the northwestern Mediterranean coast; during the lower Pliocene, the sea level raised, forming bays and estuaries. South to the Papiol village, a protected small bay was conformed between Palaeozoic hills, where plastic clays were deposited recording the local fauna. According to Solsona (1999), the gastropods recovered from the blue clays are indicators of deep depositional conditions in contrast to lateral sands around the area that indicate a shallower facies.

A systematic collection from the deposits above-mentioned, of otoliths and diverse fish remains was studied by Mr. Mañé for more than twenty years (Mañé *et. al.*, 1995, 1996; Nolf *et al.*, 1998). We recovered decapods housed within the collections of the Museu Geològic del Seminari Conciliar of Barcelona. The thalassinids object of this study were finely preserved together with a diverse macrofauna of gastropods, bivalves, leaves, and interesting but less frequent fish remains and some brachyurans, being recognised the genera *Geryon*, *Goneplax*, and rare raninoids.

Previous reports of Pliocene laomedids from Spain

The specimens of laomedids from the Pliocene of Spain are rare and limited today only to two reports. Müller (1993) reported several specimens from Molins de Rei (Martinell and Castillo collections), 35 specimens from Papiol (Mañé collection, housed in MGSB), pointing out that the poorly preserved specimens do

Fig. 1 – Geographic map with the fossiliferous locality / cartina geografica con la località fossilifera. 1) Papiol.

not make possible to separate them from the living Mediterranean *Jaxea nocturna* Nardo, 1847. Later Mayoral *et al.* (1998) reported two isolated chelae from the northwestern area of the Neogene (lower Pliocene) Guadalquivir Basin (Sevilla) ascribing them to *Jaxea* cf. *nocturna*.

Material

The studied sample includes eighteen fragmentary and articulate specimens, housed in the Museu Geològic del Seminari Conciliar of Barcelona (MGSB). The specimens are flatted on the bedding planes. Their preparation was easy as a result of the softness of the surrounding argillaceous matrix. The studied specimens are ascribed to *Jaxea nocturna* Nardo, 1847.

The systematic arrangement used in this paper follows the recent classification proposed by Tsang *et al.* (2008).

Abbreviations

P1-P5, first to fifth pereiopods.

Measurements are given in millimetres (mm).

Systematic Palaeontology

Infraorder Thalassinidea Latreille, 1831
Superfamily Thalassinoidea Latreille, 1831
Family Laomediidae Borradaile, 1903
Genus *Jaxea* Nardo, 1847

Type species: *Jaxea nocturna* Nardo, 1847, by original designation.

Included fossil species: *J. nocturna* Nardo, 1847; *J. kümeli* Bachmayer, 1954.

Jaxea nocturna Nardo, 1847
Figs. 2-6

Locality: Papiol (Barcelona).

Geological age: lower Pliocene.

Material: eighteen fragmentary and articulate specimens in dorsal and lateral view, 15-25 mm long. MGSB 51689, 51690, 51691-51693 (part and counter-part), 51692, 51765, 52051 (part and counter-part), 52052, 52053, 52054, 52056, 52057, 52058, 52059, 52060, 52061, 52062, 52606.

Discussion. Even though the preservation condition of the studied specimens did not allow a deep description, some morphological characters have been distinguished: *linea thalassinica* well defined and straight anteroposteriorly, all abdominal pleurae pointed ventrally with ventral denticles, telson with posterior margin convex and median longitudinal groove, P1 chelate, equal, greatly developed, nearly as long as body, movable finger slightly longer than fixed finger, and occlusal margins of both fingers with three or four large round teeth proximally, median triangular tooth and small round teeth in distal half.
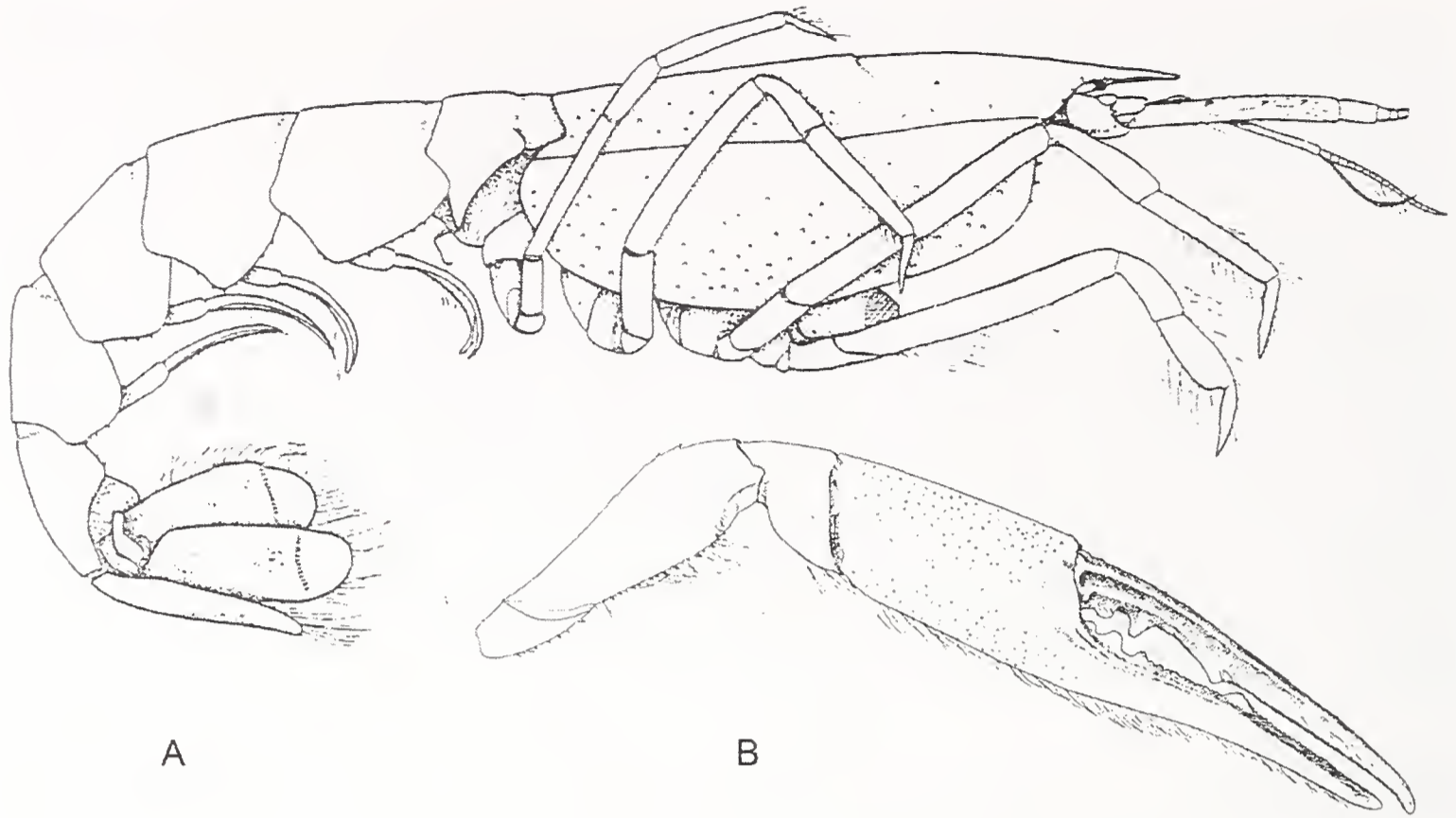
Fig. 2 – *Jaxea nocturna* Nardo, 1847. A) recostruction / ricostruzione. B) P1. Living form / forma vivente (from Ngoc-Ho, 2003 / da Ngoc-Ho, 2003).
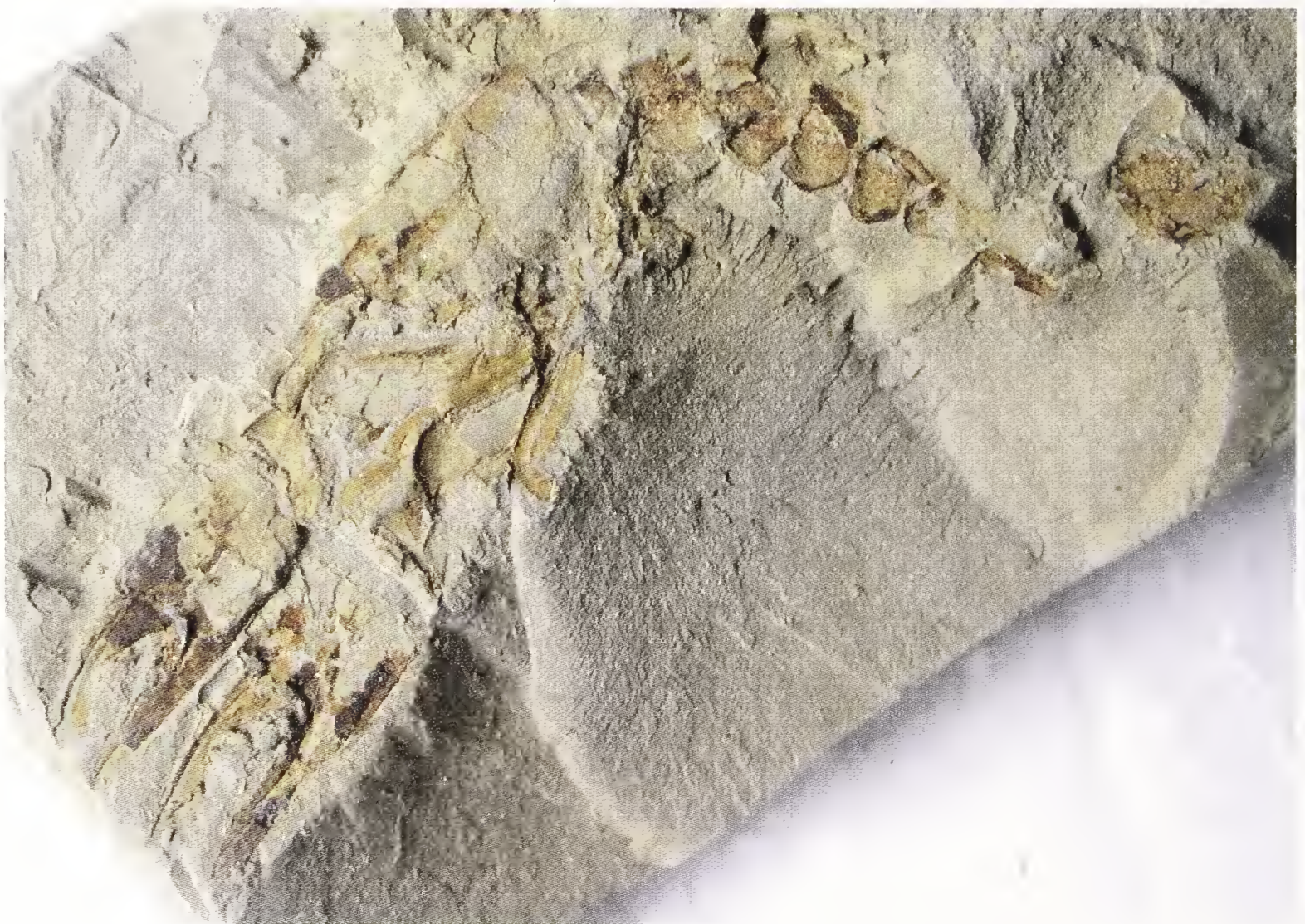
Fig. 3 – *Jaxea nocturna* Nardo, 1847, MGSB 52051 (x 1.5).

Fig. 4 – *Jaxea nocturna* Nardo, 1847, MGSB 52054 (x 2.5).

As reported by Ngoc-Ho (2003), the living *Jaxea nocturna* is characterized having following characters: triangular rostrum, pointed anteriorly; *linea thalassinica* present; cervical groove well defined; abdominal segments approximately of same length; telson longer than wide, longitudinal dorsal ridges present, posterior margin convex, median spine absent; P1 chelate, equal, and greatly developed, nearly as long as body; movable finger slightly longer than fixed finger; occlusal margins of movable and fixed fingers with three or four large round teeth proximally, median triangular tooth and small round teeth in distal half; and P2-5 slender and simple.

Most of these morphological characters are visible on the studied specimens that are ascribed to the extant *J. nocturna*, widespread in SW Scotland, Ireland, SW England, English Channel, Bay of Biscay, Canyon of Capbreton, and Marseille (France), South Spain, Atlantic coast of Morocco, and East Mediterranean Sea (Ngoc-Ho, 2003).

Fig. 5 – *Jaxea nocturna* Nardo, 1847, MGSB 52052 (x 2.5).

At present, *Jaxea* cfr. *nocturna* is reported only from the Pliocene of Tuscany (Italy) (Delle Cave, 1988). The author pointed out that the poor preservation of fossils did not allow to distinguish them from the living Mediterranean species. The oldest species of *Jaxea* could be *J. kümeli* from the Miocene of Hungary and Austria (Bachmayer, 1954). The author justified the erection of the new species, different from the living one, for its smaller size and slightly slender form. However, Müller (1993) and Mayoral *et al.* (1998) questioned the real systematic validity of this species, pointing out its similarity with the living form for some morphological characters. Finally, some undeterminated chelae known from the lower Miocene (Karpatian) of North Hungary (Müller, 1993) are very similar in shape to those of the living form.

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Fig. 6 – *Jaxea nocturna* Nardo, 1847, MGSB 51689 (x 3.5).

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Massimo Plumari

New records of Ascidae and Blattisociidae species from Italy (Acarina, Mesostigmata)

Abstract - Two genera, *Hoploseius* Berlese, 1914 and *Neojordensia* Evans, 1957 and five species of Ascidae and Blattisociidae are recorded for the first time from Italy: *Iphidozercon corticalis* Evans, 1958, *Neojordensia sinuata* Athias-Henriot, 1973 and *Zerconopsis michaeli* Evans & Hyatt, 1960 (Ascidae), *Cheiroseius cassiteridum* (Evans & Hyatt, 1960) and *Hoploseius bispinosetus* Faraji & Sakenin-Chelav & Karg, 2006 (Blattisociidae). The record of *H. bispinosetus* is the second documented and the first for Europe. New records for *Arctoseius taeniolatus* Athias-Henriot, 1960 and *Zerconopsis remiger* (Kramer, 1876) (Ascidae), *Cheiroseius necorniger* (Oudemans, 1903), *Lasioseius muricatus* (Koch C. L., 1839), *Lasioseius youcefi* Athias-Henriot, 1959 and *Zercoseius spathuliger* (Leonardi, 1899) (Blattisociidae), are also given.

Key words: Ascidae, Blattisociidae, *Hoploseius bispinosetus*, new records, Italy.

Riassunto - Nuove segnalazioni per l'Italia di specie di Ascidae e Blattisociidae (Acarina, Mesostigmata).

Vengono segnalati due generi, *Hoploseius* Berlese, 1914 e *Neojordensia* Evans, 1957 e cinque specie di Ascidae e Blattisociidae nuovi per l'Italia: *Iphidozercon corticalis* Evans, 1958, *Neojordensia sinuata* Athias-Henriot, 1973 e *Zerconopsis michaeli* Evans & Hyatt, 1960 (Ascidae), *Cheiroseius cassiteridum* (Evans & Hyatt, 1960) e *Hoploseius bispinosetus* Faraji & Sakenin-Chelav & Karg, 2006 (Blattisociidae). Per *H. bispinosetus* si tratta della seconda segnalazione documentata della specie e della prima per l'Europa. Vengono inoltre segnalate nuove località per *Arctoseius taeniolatus* Athias-Henriot, 1960 e *Zerconopsis remiger* (Kramer, 1876) (Ascidae), *Cheiroseius necorniger* (Oudemans, 1903), *Lasioseius muricatus* (Koch C.L., 1839), *Lasioseius youcefi* Athias-Henriot, 1959 e *Zercoseius spathuliger* (Leonardi, 1899) (Blattisociidae).

Parole chiave: Ascidae, Blattisociidae, *Hoploseius bispinosetus*, nuove località, Italia.

Introduction

The mites of the families Ascidae and Blattisociidae are a large group of mostly free-living Mesostigmata which has successfully colonized many terrestrial and semi-aquatic habitats.

These two families were recently reconsidered and the family called Ascidae Voigts & Oudemans, 1905 was broken into Melicharidae, Ascidae, and Blattiso-

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ciidae (Walter, 2006). About forty species of mesostigmatid mites, belonging to genera included in these families, are recorded from Italy, but they were listed according to the previous classification (Bernini *et al.*, 1995; Castagnoli & Nannelli, 2003; Stoch, 2003; Plumari, 2003, 2008). However, some common European species are not recorded so far and some others were not investigated. Moreover, the checklist of these taxa must be revised for the Italian distribution, taxonomic classification in use and species inquirendae.

In this study I report the first record of two genera, *Hoploseius* Berlese, 1914 and *Neojordensia* Evans, 1957 and five species of Ascidae and Blattisociidae from Italy: *Iphidozercon corticalis* Evans, 1958, *Neojordensia sinuata* Athias-Henriot, 1973 and *Zerconopsis michaeli* Evans & Hyatt, 1960 (Ascidae), *Cheiroseius cassiteridum* (Evans & Hyatt, 1960) and *Hoploseius bispinosetus* Faraji & Sakenin-Chelav & Karg, 2006 (Blattisociidae).

The record of *H. bispinosetus* is the second documented and the first from Europe.

New records for *Arctoseius taeniolatus* Athias-Henriot, 1960 and *Zerconopsis remiger* (Kramer, 1876) (Ascidae), *Cheiroseius necorniger* (Oudemans, 1903), *Lasioseius muricatus* (C.L. Koch, 1839), *Lasioseius youcefi* Athias-Henriot, 1959 and *Zercoseius spathuliger* (Leonardi, 1899) (Blattisociidae), are also given.

Some remarks about the geographical distribution and ecology and selected references helpful for their identification, are supplied for each species.

Materials and Methods

Mites were extracted from samples of litter, bark, moss, wood inhabiting fungi and washed ashore material, in a modified Berlese-Tullgren funnel and collected specimens were preserved in 70 % ethanol. The mites were identified after clearing in lactic acid and slide-mounted in Hoyer's medium. I used the keys of Evans & Hyatt (1960), Karg (1981, 1993) and Gwiazdowicz (2003) in order to identify the mites. The classification used for the families Ascidae and Blattisociidae follows Walter (2006).

All of the collected specimens are deposited in the Civic Museum of Lentate sul Seveso, Milan, Italy.

Family **Ascidae** *sensu* Walter, 2006

Arctoseius taeniolatus Athias-Henriot, 1961

1961 – *Arctoseius taeniolatus* Athias-Henriot; p. 456, Text-figs. 196-198
2007 – *Arctoseius taeniolatus* Athias-Henriot *in* Gwiazdowicz; p. 129, Text-fig. 133

Material examined. TUSCANY, 62 ♀♀ and 5 ♂♂, Grosseto, Capalbio, WWF oasis "Lake of Burano", 27.XII.1997, M. Plumari leg., leaf litter, in *Quercus ilex* and *Q. suber* coast wood; TUSCANY, 10 ♀♀, Lucca, Migliarino-S. Rossore-Massaciuccoli Regional Park, Macchia Lucchese, Torre del Lago Puccini, 19.VIII.2006, M. Plumari leg., litter under *Laurus nobilis*.

Distribution and ecology. *A. taeniolatus* was collected originally in Italy (Alpi Apuane, Lucca, Stazzema) from soil, and in Spain from habitat with *Atriplex halimus* (Chenopodiaceae) (Athias-Henriot, 1961).

More recently *A. taeniolatus* was recorded from Poland, from soil environment (Skorupski, 2001) and from litter of alder swamp forest and litter of old pine forest (Gwiazdowicz, 2007).

Remarks. *A. taeniolatus* was not listed among the species of the genus *Arctoseius* Thor, 1930 recorded from Europe (Karg, 1993) and Italy (Bernini *et al.*, 1995; Castagnoli & Nannelli, 2003; Stoch, 2003).

Iphidozercon corticalis Evans, 1958

1958 – *Iphidozercon corticalis* Evans; p. 214, Text-figs. 62-64
1963 – *Leioseius (Arctoseius) elegans* Bernhard; p. 119, Text-figs. 59-61
1993 – *Arctoseius elegans* Bernhard *in* Karg; p. 263, Text-figs. 206b, 207b, 208a
2003 – *Iphidozercon corticalis* Evans *in* Gwiazdowicz; p. 153, Text-figs. 7b, 8a
2007 – *Iphidozercon corticalis* Evans *in* Gwiazdowicz; p. 136, Text-fig. 146

Material examined. LOMBARDY, 29 ♂♂ and 28 ♀♀, Milan, Parco sovracomunale della Brughiera Briantea, Mariano Comense, "Cascina Mordina", 31.III.2001, M. Plumari leg., dunghill.

Distribution and ecology. *Iphidozercon corticalis* was collected originally in Great Britain from bark of fruit tree (Evans, 1958). Later, this species was recorded from the following countries: Australia, in compost (Halliday *et al.*, 1998); Germany, from heaps of rotten vegetable material (Bernhard, 1963); Korea, soil of some forest habitats (Kaczmarek & Lee, 2000); Poland (Skorupski & Gwiazdowicz, 1996), in dung of *Bison bonasus* (L.) and moss (Gwiazdowicz, 2007).

Halliday *et al.* (1998) reared all of the instars of this mite feeding them with a variety of nematodes. Also, those authors assert that *I. corticalis* is a synanthropic species with cosmopolitan distribution.

Remarks. The following new synonymies were proposed by Halliday *et al.* (1998): *Iphidozercon corticalis* Evans, 1958 = *Iphidozercon californicus* Chant, 1963 = *Leioseius (Arctoseius) elegans* Bernhard, 1963 = *Iphidozercon variolatus* Ishikawa, 1969.

However, Gwiazdowicz (2003) pointed out that *I. corticalis* and *I. californicus* differ for some characters.

Neojordensia sinuata Athias-Henriot, 1973

1973 – *Neojordensia sinuata* Athias-Henriot; p. 26
1993 – *Neojordensia sinuata* Athias-Henriot *in* Karg; p. 247, Text-fig. 185d
2007 – *Neojordensia sinuata* Athias-Henriot *in* Gwiazdowicz; p. 101, Text-fig. 93

Material examined. PIEMONTE, 1 ♀, Novara, Mount Fenera Natural Park, Grignasco, Magiaiga stream, "Grotte di Ara", 07.IV.2007, M. Plumari leg., under stone on stream bank.

Distribution and ecology. *Neojordensia sinuata* is an European species found in sand amid roots of *Ammophila arenaria* and under vegetable remnants (Karg, 1993; Gwiazdowicz *et al.*, 2007). This species was collected also in the following microhabitats: bird nests (Fenďa, 1999; Gwiazdowicz, 2007), soil environment

(Skorupski, 2001), river mud and silt of oak-hornbeam forest, leaf litter and moss of alder and spruce swamp forest (Gwiazdowicz & Klemt, 2004; Gwiazdowicz, 2007), wet sandy clay soil and dead plants near water (Salmane, 2006), sods of grass in alder swamp forest (Gwiazdowicz, 2007).

Zerconopsis michaeli Evans & Hyatt, 1960

1960 – *Zerconopsis michaeli* Evans & Hyatt; p. 95, Text-figs. 189-191
1993 – *Zerconopsis michaeli* Evans & Hyatt *in* Karg; p. 262, Text-fig. 205b
2007 – *Zerconopsis michaeli* Evans & Hyatt *in* Gwiazdowicz; p. 141, Text-fig. 154

Material examined. LOMBARDY, 1 ♂, Milan, Groane Regional Park, Cesate, 10.XII.2006, M. Plumari leg., bark of dead *Pinus sylvestris*; LOMBARDY, 5 ♂♂, 10 ♀♀ and 4 deutonymphs, Milan, Parco sovracomunale della Brughiera Briantea, Meda, 02.IX.2007, M. Plumari leg., fruiting bodies of *Piptoporus betulinus*; LOMBARDY, 3 ♀♀, Ticino Regional Park, Pavia, Vigevano, "Tenuta Ronchi", 10.II.2008, M. Plumari leg., fruiting bodies of *Coriolopsis trogii* on *Populus nigra*. MARCHE, 2 ♀♀, Ancona, Monte Conero Regional Park, Sirolo, 01.IX.2008, M. Plumari leg., rotting log. of *Pinus halepensis*.

Distribution and ecology. Originally collected in England (Evans & Hyatt, 1960), *Z. michaeli* has been recorded later on from Middle Europe, found in dry humus, rotting wood and litter of mixed woods (Karg, 1993; Gwiazdowicz *et al.*, 2007), from bark, rotting logs and stumps, ant nests (Skorupski, 2001), from leaf litter (Kontschán, 2007), in fruiting bodies of bracket fungi and litter from several forest ecosystems (Gwiazdowicz, 2007).

Remarks. According to Gwiazdowicz (2007), all of the collected specimens have four pairs of paddle-like setae on the dorsal shield, whereas Evans & Hyatt (1960) reported three pairs; yet the other features match Evans & Hyatt's (l.c.) description. In his diagnosis of *Z. michaeli*, Kontschán (2007) reported only three pairs of setae with "spatula-form" (s4, Z3 and Z5), however in his original drawing of this species (fig.7, p. 101) there are four pairs of paddle-like setae (s4, s6, Z3 and Z5), confirming my observations and those of Gwiazdowicz (2007).

The usefulness of the s6 seta shape for the diagnosis of *Z. michaeli* and the potential intraspecific variability of this character should be evaluated by an examination of other specimens, collected possibly near the type locality.

Zerconopsis remiger (Kramer, 1876)

1876 – *Gamasus remiger* Kramer; p. 93
1910 – *Ameroseius bispinosus* Berlese; p. 253
1960 – *Zerconopsis remiger* (Kramer) *in* Evans & Hyatt; p. 92, Text-figs. 179-183
1961 – *Zerconopsis remiger* (Kramer) *in* Schweizer; p. 136, Text-fig. 175
1963 – *Lasioseius (Lasioseius) remiger* (Kramer) *in* Westerboer; p. 228, Text-figs. 109-117
1993 – *Zerconopsis remiger* (Kramer) *in* Karg; p. 262, Text-fig. 201a
2007 – *Zerconopsis remiger* (Kramer) *in* Gwiazdowicz; p. 143, Text-fig. 159

Material examined. LOMBARDY, 1 ♂ and 5 ♀♀, Como, Faggeto Lario, Lemna, 29.V.2005, M. Plumari leg., from bark of dead *Picea excelsa*; LOMBARDY, 1 ♂ and 13 ♀♀, Varese, Parco Regionale della Pineta di Appiano Gentile, Appiano Gentile, 26.III.2006, M. Plumari leg., under bark of dead *Pinus sylvestris*; LOMBARDY, 2 ♀♀, Brescia, Riserva Naturale Valli di Sant'Antonio, Valle di Campovecchio, 1300 m ca., 02.IX.2006, M. Plumari leg., from fruiting bodies of *Heterobasidion annosum* on *Picea excelsa*; LOMBARDY, 2 ♀♀, Varese, Parco Regionale della Pineta di Appiano Gentile, Lurago Marinone, 25.III.2007, M. Plumari leg., from bark of dead *Pinus sylvestris*.

Distribution and ecology. *Zerconopsis remiger* is a common European species (Westerboer, 1963; Karg, 1993; Gwiazdowicz *et al.*, 2007) recorded from several countries and found in many habitats: Bulgaria (Deltshev *et al.*, 1998); Great Britain and Hungary (Evans & Hyatt, 1960); North Italy (Südtirol, Bolzano, Terento), on *Ula sylvatica* (Meigen) (Diptera Pediciidae) (Rack, 1976), peninsular Italy and Sicily (Bernini *et al.*, 1995; Stoch, 2003); Latvia, fungal fruiting bodies and litter (Salmane, 2005a, 2005b); Poland, soil environment (Skorupski, 2001), fungal fruiting bodies (Gwiazdowicz & Łakomy, 2002), several forest ecosystems and microhabitats (Gwiazdowicz, 2007); Romania, litter (Stănescu & Gwiazdowicz, 2004); Slovakia (Holecová *et al.*, 2005); Spain, moss and rotten bark (Athias-Henriot C., 1961); Slovakia (Kaluz, 1993); Switzerland, humus and roots (Schweizer, 1961). Westerboer (1963) recorded this species also from Germany and Ireland.

Remarks. *Zerconopsis remiger* is not recorded from North Italy in Italian acarofauna's checklist (Bernini *et al.*, 1995; Castagnoli & Nannelli, 2003; Stoch, 2003).

Family **Blattisociidae** *sensu* Walter, 2006

Cheiroseius cassiteridum (Evans & Hyatt, 1960)

1960 – *Sejus cassiteridum* Evans & Hyatt; p. 61, Text-figs. 74-78
1961 – *Sejus crassiteridum* Evans & Hyatt *in* Athias-Henriot; p. 445
1981 – *Cheiroseius (Posttrematus) cassiterridium* (Evans & Hyatt) *in* Karg; p. 58
1993 – *Cheiroseius (Posttrematus) cassiteridium* (Evans & Hyatt) *in* Karg; p. 258, Text-fig. 194a

Material examined. LIGURIA, 1 ♀, Savona, Monte Beigua Regional Park, Piampaludo, near "Torbiera del Laione", 21.I.2007, M. Plumari leg., damp moss; LOMBARDY, 1 ♀, Como, Albate, WWF oasis "Il Bassone", 07.XII.2007, M. Plumari leg., moss in flooded wood of *Alnus glutinosa*.

Distribution and ecology. Originally collected in England from roots of rushes and from *Sphagnum* (Evans & Hyatt, 1960), *Cheiroseius cassiteridum* was subsequently recorded from other European countries: Latvia, from washed ashore material and reeds (Salmane, 2005b) and Bulgaria (Deltshev *et al.*, 1998). Karg (1981, 1993) reported general distribution for Europe and South America. This species was recorded also from Algeria, collected from roots of rushes (Athias-Henriot, 1961), Colorado (United States Geological Survey, 1994) and Australia (Halliday, 2000).

Cheiroseius necorniger (Oudemans, 1903)

1903 – *Hypoaspis necorniger* Oudemans; p. 87
1952 – *Episeius necorniger* (Oudemans) *in* Willmann; p. 148
1960 – *Sejus necorniger* (Oudemans) *in* Evans & Hyatt; p. 55, Text-figs. 59-62
1961 – *Platyseius necorniger* (Oudemans) *in* Schweizer; p. 124, Text-fig. 152
1981 – *Cheiroseius* (*Posttrematus*) *necorniger* (Oudemans) *in* Karg; p. 58, Text-fig. 6d
1993 – *Cheiroseius* (*Posttrematus*) *necorniger* (Oudemans) *in* Karg; p. 257, Text-figs. 194b,c
2007 – *Cheiroseius* (*Posttrematus*) *necorniger* (Oudemans) *in* Gwiazdowicz; p. 152, Text-fig. 174

Material examined. LOMBARDY, 14 ♀♀, Ticino Regional Park, Pavia, Bereguardo, "Bosco della Zelata", 07.V.2006, M. Plumari leg., under stones on stream bank; LOMBARDY, 21 ♀♀, Lecco, Pusiano Lake, Casletto, 14.V.2006, M. Plumari leg., under stones on lake shore; EMILIA ROMAGNA, 1 ♀, Parma, Cento Laghi Park, Corniglio, "Lagoni", 29.X.2006, M. Plumari leg., under stone on lake shore; LOMBARDY, 2 ♀♀, Garda Lake, Brescia, Toscolano Maderno, 28.XII.2007, M. Plumari leg., washed ashore material.

Distribution and ecology. A widespread species recorded from several European countries (Karg, 1993): Bulgaria (Deltshev *et al.*, 1998); Czech Republic (Kohn, 1982), on *Culicoides pallidicornis* Kieffer (Diptera Ceratopogonidae) (Mašán & Országh, 1995); Germany (Willmann, 1952; Rack, 1976); Great Britain, saltmarsh (Luxton, 1967); North Italy (Südtirol, Monte Baldo), on *Erioptera stictica* (Meigen) (Diptera Limoniidae) (Rack, 1976); Latvia, agroecosystems, calcareous bog, coastal meadows, washed ashore material (Salmane, 2001a), driftline habitats (Salmane, 2001b), strawberry agroecosystems (Petrova *et al.*, 2004); Norway (Gwiazdowicz & Gulvik, 2005); Poland, on small mammals (Haitlinger, 1987), "wormdust" (Gwiazdowicz & Szadkowski, 2000), ecotone between Scots pine forest and meadow (Seniczak *et al.*, 2000), moss and sod (Gwiazdowicz & Kmita, 2004), several forest ecosystems and microhabitats (Gwiazdowicz, 2007); Russia (Marchenko, 1998); Switzerland, thermal spring and moss (Schweizer, 1961).

Cheiroseius necorniger was recorded also from Africa (Karg, 1993; Halliday, 2005) and Evans & Hyatt (1960) examined specimens from Great Britain, Germany, Montenegro and Transvaal.

Remarks. I collected most specimens by sight on shores under stones covered with mud and organic sediment. *Cheiroseius necorniger* is very common in this microhabitat. This species was not listed among the species of the genus *Cheiroseius* Berlese, 1916 recorded from Italy (Bernini *et al.*, 1995; Castagnoli & Nannelli, 2003; Stoch, 2003).

Hoploseius bispinosetus Faraji & Sakenin-Chelav & Karg, 2006

2006 – *Hoploseius bispinosetus* Faraji & Sakenin-Chelav & Karg; p. 69, Text-figs. 1-13

Material examined. LOMBARDY, 37 ♀♀, Milan, Parco sovracomunale della Brughiera Briantea, Meda, 24.I.1999, M. Plumari leg., fruiting bodies of polypo-

rus; LOMBARDY, 1 ♀, Como, Albate, WWF oasis “Il Bassone”, 07.XII.2007, M. Plumari leg., fruiting bodies of *Daedaleopsis confragosa* on *Salix caprea*; LOMBARDY, 52 ♀♀, Como, Alserio Lake, Alserio, 20.I.2008, M. Plumari leg., fruiting bodies of *Coriolopsis trogii* on *Populus nigra*; LOMBARDY, 7 ♀♀, Ticino Regional Park, Pavia, Vigevano, “Tenuta Ronchi”, 10.II.2008, M. Plumari leg., fruiting bodies of *Coriolopsis trogii* on *Populus nigra*; FRIULI VENEZIA GIULIA, 2 ♂♂ and 18 ♀♀, Gorizia, Staranzano, Isola della Cona, 25.III.2008, M. Plumari leg., fruiting bodies of *Coriolopsis trogii* on *Populus sp.*

Distribution and ecology. *Hoploseius bispinosetus* was recently described on the basis of four specimens, three females and one male, collected from fungi of decaying wood, from Northern Iran.

Remarks. The nine species attributed so far to the genus *Hoploseius* Berlese, 1914 were collected from fungal fruiting bodies or phoretic on mycetophagous flies.

Only *H. mariae* Gwiazdowicz, 2002 is recorded from Europe, whereas the remaining *Hoploseius* species are known from North America, Africa, Asia and Australia.

H. bispinosetus is the only species of the genus with enlarged and spine-like dorsal setae *I4* (Faraji & Sakenin-Chelav & Karg, 2006).

I collected *H. bispinosetus* always from fruiting bodies of polyporous fungi. However, because most material was collected together with several specimens of *Cis bidentatus* (Olivier) (Coleoptera Ciidae), *H. bispinosetus* may be associated with these beetles.

This record is the second for *H. bispinosetus* and the first for the same species relative to Europe.

The finding of this species in the “Parco sovracomunale della Brughiera Briantea”, a suburban park regarded of little importance, contribute to increase the natural value of this area and relative habitats.

Lasioseius muricatus (C.L. Koch, 1839)

1839 – *Sejus muricatus* C.L. Koch
1922 – *Ameroseius pseudocometa* Schweizer; p. 42
1941 – *Aceoseius muricatus* (C.L. Koch) *in* Sellnick; p. 149
1958 – *Lasioseius muricatus* (C.L. Koch) *in* Evans; p. 218, Text-fig. 69
1961 – *Aceoseius muricatus* (C.L. Koch) *in* Schweizer: p.132, Text-fig. 168
1963 – *Aceoseius muricatus* (C.L. Koch) *in* Bernhard; p. 51, Text-figs. 5-16
1993 – *Aceoseius muricatus* (C.L. Koch) *in* Karg; p. 248, Text-figs. 185b, 187b, 191f
2007 – *Lasioseius muricatus* (C.L. Koch) *in* Gwiazdowicz; p. 85, Text-fig. 66

Material examined. EMILIA ROMAGNA, 26 ♀♀ and 4 ♂♂, Po Delta Park, Ravenna, Pineta di Classe, 29.IV.2007, M. Plumari leg., under bark of dead *Pinus pinea*; LOMBARDY, 12 ♀♀, Ticino Regional Park, Pavia, Vigevano, “Tenuta Ronchi”, 10.II.2008, M. Plumari leg., fruiting bodies of *Coriolopsis trogii* on *Populus nigra*.

Distribution and ecology. *Lasioseius muricatus* is a common species mostly recorded from Middle Europe (Karg, 1993) and found in fungal fruiting bodies and rotten wood: Great Britain, on *Polyporus* (Evans, 1958); Hungary (Kontschán,

2007); Latvia, banks of ditches (Salmane, 2001a), many fungal fruiting bodies and some microhabitats from forest ecosystems (Salmane, 2005a); Poland, rotten wood (Gwiazdowicz & Szadkowski, 2000), soil, bark, rotting logs and stumps, ants' nests (Skorupski, 2001), fungal fruiting bodies (Gwiazdowicz & Łakomy, 2002), rotten wood and root in alder forest (Gwiazdowicz & Klemt, 2004), many fungal fruiting bodies and some microhabitats from forest ecosystems (Gwiazdowicz, 2007); Slovakia, oak-hornbeam forest ecosystem (Holecová *et al.*, 2005); Switzerland, from *Polyporus* (Schweizer, 1961).

However, the records from Italy, in ants' nest (Plumari, 2003) and above records, from Republic of Komi, in fungal fruiting bodies (Makarova, 2004) and from Norway (Gwiazdowicz & Gulvik, 2005), show that *L. muricatus* is widespread throughout the Europe.

Remarks. *Lasioseius muricatus* (C.L. Koch) (= *Sejus muricatus* C.L. Koch, 1839) must not be confused with the type species of the genus *Lasioseius* Berlese, 1916, i.e. *L. berlesei* (Oudemans) (= *Seius muricatus* Berlese, 1887).

Lasioseius muricatus was not listed among the species of the genus *Lasioseius* Berlese, 1916 recorded from Italy (Bernini *et al.*, 1995; Castagnoli & Nannelli, 2003; Stoch, 2003).

Lasioseius youcefi Athias-Henriot

1959 – *Lasioseius youcefi* Athias-Henriot; p. 177, Text-figs. 24, 26g-k
1989 – *Lasioseius youcefi* Athias-Henriot *in* Walter & Lindquist; p. 2800, Text-figs. 3, 4, 17, 19c,d,g
1993 – *Lasioseius youcefi* Athias-Henriot *in* Karg; p. 254, Text-fig. 192b
2005 – *Lasioseius youcefi* Athias-Henriot *in* Halliday; p. 21
2006 – *Lasioseius youcefi* Athias-Henriot *in* Christian & Karg; p. 219, Text-fig. 9.1
2007 – *Lasioseius youcefi* Athias-Henriot *in* Gwiazdowicz; p. 88, Text-fig. 72

Material examined. EMILIA ROMAGNA, 1 ♀, Po Delta Park, Ravenna, Marina Romea, 30.X.2005, M. Plumari leg., washed ashore material on sandy beach.

Distribution and ecology. *Lasioseius youcefi* is recorded from North and South America, Eurasia, and temperate areas of northern and southern Africa (Athias-Henriot, 1959; Walter & Lindquist, 1989; Karg, 1993; Lee & Lee, 1998; Halliday, 2005; Christian & Karg, 2006; Gwiazdowicz, 2007). Originally this species was found on the ground of a market garden and in wet mosses from a gorge (Athias-Henriot, 1959). In Europe it was collected from agroecosystems, inland and coastal meadows, spruce stands, bogs, mosses, litter, rotting vegetable remnants, fungi, straw, rotten apples, bark beetle galleries and nests of small rodents and birds (Karg, 1993; Salmane, 2001a, 2005a; Gwiazdowicz, 2007). In Colorado, *L. youcefi* is seemingly a specialist of canyon grassland sites along the streams (Walter & Lindquist, 1989). In laboratory *L. youcefi* breeds by thelytokous parthenogenesis and is omnivorous, feeding on fungi and animal prey (Walter & Lindquist, 1989).

Remarks. Walter & Lindquist (1989) assert that in the Berlese Collection in Florence, Italy, some slides of *Lasioseius berlesei* (Oudemans, 1938), i.e. 7/45, 27/36, 168/37, 176/35, 201/12 and 43/46, contain also females of *L. youcefi*.

The Berlese's material was collected in decaying leaf litter from Castiòns di Strada (Friuli Venezia Giulia, Udine), in humus from Sila woods (Calabria, Cosenza), from Pistoia (Tuscany) and unspecified locality named Fiumicello (Castagnoli & Pegazzano, 1985).

The finding of Walter & Lindquist (1989) and the record reported in this study show that *L. youcefi* is widespread throughout the Italy.

However, *L. youcefi* was not listed among the species of the genus *Lasioseius* Berlese, 1916 recorded from Italy (Bernini *et al.*, 1995; Castagnoli & Nannelli, 2003; Stoch, 2003).

Zercoseius spathuliger (Leonardi)

1899 – *Seius spathuliger* Leonardi; p. 923
1905 – *Ameroseius zerconiformis* Berlese; p. 234
1958 – *Zercoseius spathuliger* Leonardi *in* Evans; p. 196, Text-figs. 28-29
1961 – *Zercoseius spathuliger* Leonardi *in* Athias-Henriot; p. 453, Text-figs. 58, 74
1963 – *Lasioseius (Lasioseius) spathuliger* Leonardi *in* Westerboer; p. 221, Text-figs. 104-108
1993 – *Zercoseius spathuliger* Leonardi *in* Karg; p. 283, Text-fig. 222
2007 – *Zercoseius spathuliger* Leonardi *in* Gwiazdowicz; p. 120, Text-fig. 119

Material examined. EMILIA ROMAGNA, 3 ♀♀, Po Delta Park, Ferrara, Volano, Pineta Demaniale Po di Volano, 26.III.2005, M. Plumari leg., rotting log of *Pinus pinaster*.

Distribution and ecology. *Zercoseius spathuliger* is recorded from Europe and northern Africa (Athias-Henriot, 1961; Karg, 1993; Gwiazdowicz *et al.*, 2007): Algeria, several soil microhabitats in forest, maquis and pseudo-steppe ecosystems (Athias-Henriot, 1959, 1961); Corsica, *Cistus sp.* litter (Athias-Henriot, 1961); Great Britain, moss and humus under deciduous stands (Evans, 1958); Iberian peninsula and Balearic Islands, in many ecosystems and microhabitats (Athias-Henriot, 1961; Moraza, 2006, 2007); peninsular Italy and Sicily (Bernini *et al.*, 1995; Stoch, 2003); Poland, soil environment (Skorupski, 2001), litter and moss (Gwiazdowicz, 2007). Westerboer (1963) recorded this species also from Ireland and Austria.

Remarks. *Zercoseius spathuliger* is not recorded from North Italy in Italian acarofauna's checklist (Bernini *et al.*, 1995; Castagnoli & Nannelli, 2003; Stoch, 2003).

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A new specimen of trematosaurian temnospondyl from the Lower Triassic of NW Madagascar, with remarks on palatal anatomy and taxonomic affinities

Abstract - A new partial skull (preserved as a natural mould) of a trematosaurid temnospondyl from the Lower Triassic of the Ankitokazo Basin, Diégo Suarez Province, NW Madagascar, is described. It provides new information on the palatal anatomy, poorly known in the Malagasy trematosaurids, the more important concerning the morphology of the cultriform process, which is squared in cross section and comparatively wide. The new specimen represents a taxon well distinct from both Malagasy lonchorhynchine trematosaurid *Wantzosaurus elongatus* and other trematosaurid genera known out of Madagascar. The taxonomic and phylogenetic affinities found between the new skull and all the Malagasy non-lonchorhynchine specimens so far described suggest that the material may belong to a single species, closely related to the German species *Trematolestes hagdorni*, and more similar to *Tertrema acuta* than to *Trematosaurus brauni*. The new skull is therefore tentatively referred to cf. *Tertremoides madagascariensis*, the only non-lonchorhynchine trematosaurid species from Madagascar that we regard as valid, following the systematic review by Schoch & Milner (2000).

Key words: Trematosauridae, Lower Triassic, NW Madagascar, palatal anatomy, cf. *Tertremoides madagascariensis*.

Riassunto - Un nuovo esemplare di temnospondilo trematosauriano del Triassico inferiore del Madagascar nord-occidentale, con commenti sull'anatomia del palato e sulle affinità tassonomiche.

Viene qui descritto un nuovo cranio parziale, conservato come modello, di un temnospondilo trematosauride del Triassico inferiore del bacino di Ankitokazo, Provincia di Diégo Suarez, Madagascar nord-occidentale. L'esemplare fornisce nuovi dati sull'anatomia del palato, regione fino ad oggi poco conosciuta nei trematosauridi malgasci. L'aspetto più importante riguarda la morfologia del processo cultriforme del parasfenoide, che è squadrato in sezione trasversale e relativamente ampio. Il nuovo esemplare rappresenta un taxon ben distinto sia dalla specie malgascia dal muso allungato *Wantzosaurus elongatus*, sia dagli altri trematosauridi non malgasci sinora noti. Le affinità tassonomiche e filogenetiche riscontrate tra il nuovo cranio e tutti gli esemplari di trematosauridi malgasci dal muso non allungato ad oggi descritti suggeriscono inoltre che tutto il materiale potrebbe appartenere ad un'unica specie, strettamente imparentata alla forma tedesca *Trematolestes hagdorni* e più affine a *Tertrema acuta* che a *Trematosaurus brauni*. Il nuovo esemplare è perciò provvisoriamente riferito a cf. *Tertremoides madagascariensis*, unica specie di trematosauride Malgascio dal muso non allungato che consideriamo valida seguendo la revisione sistematica di Schoch & Milner (2000).

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Parole chiave: Trematosauridae, Triassico inferiore, NO Madagascar, anatomia del palato, cf. *Tertremoides madagascariensis*.

Introduction

Malagasy Trematosauroidea (*sensu* Yates & Warren, 2000) are known since Lehman (1961, 1966, 1979), who listed the presence of seven different genera in the Lower Triassic of NW of the island. With the exception of *Lyrosaurus*, which is in all likelihood a junior synonym of the rhytidosteid *Mahavisaurus* (Cosgriff & Zawiskie, 1979; Maganuco *et al*., in prep.), the other six genera are based on genuine trematosaurid material. As reported by several authors (e.g., Steyer, 2002), however, Lehman overestimated the number of the Malagasy trematosaurid taxa, which can be reconducted to two morphotypes only: a gaharial-like morphotype with very elongate rostrum, especially in the prenarial portion; a second one, with rostrum comparatively short in respect to those of the gaharial-like forms.

The long-snouted, gaharial-like material was recently redescribed by Steyer (2002) and belongs to a single species of lonchorhynchine trematosaurid, *Wanzosaurus elongatus* Lehman, 1961. Aside from the holotypic, adult skull, Steyer (2002) described a partial skeleton of a juvenile individual, adding considerable information to the anatomy and ontogeny of the species, as well as to the phylogeny of the trematosaurids. Actually, *Wantzosaurus elongatus* represents the only undisputed, well-characterized Malagasy trematosaurid. According to Schoch & Milner (2000), it includes also two junior synonyms, each one erected by Lehman (1966) on the basis of a single, fragmentary skull roof: *Ifasaurus elongatus* (Lehman, 1966: pl. V B) and *Aphaneramma sp.* (Lehman, 1966: pl. VII D).

The other three Malagasy taxa originally listed and described as Malagasy trematosaurids are the species *Trematosaurus madagascariensis* Lehman, 1966 and *Tertremoides ambilobensis* Lehman, 1979, and material referred by Lehman (1979) to the genus *Tertrema*.

Material referred to *Trematosaurus madagascariensis* includes several specimens: a skull in dorsal view lacking the tip of the snout and part of the right side (Lehman 1966, pl. IV B); skull and mandible at closed jaws lacking part of the posterior half of the postorbital region (holotype - Lehman 1966, pl. V B; pl. VI A, B); a complete skull preserved in dorsal and occipital views (Lehman 1979, pl. II A, B); and a partial skull roof and mandible preserving also some dorsal scutes (Janvier, 1992: pl. I, pl. II-1).

Malagasy material referred to *Tertrema* consists of a single rostral portion of a snout, visible in dorsal and palatal view (Lehman, 1979: figs. 1, 2; pl. I A, B).

Tertremoides ambilobensis is represented by a single but almost complete skull roof, with the dorsal half of the mandible visible in lateral view (Lehman, 1979: fig. 4, pl. III A, B).

The synonymy of Lehman's species *Trematosaurus madagascariensis* and *Tertremoides ambilobensis* was proposed by Schoch & Milner (2000: 115), on the basis of the "similar morphology of the postorbital skull table and the course and expression of the lateral line sulci". Those authors referred all the material to the genus *Tertremoides*, under the combination *Tertremoides madagascariensis*, because of the many differences respect to the genus *Trematosaurus*. Schoch & Milner (2000) listed under the genus *Tertrema*, without any detailed comments, the snout-tip previously referred to *Tertrema* by Lehman (1979).

About the presence of *Tertrema* in Madagascar, Steyer (2002) reported that the material, subsequently to Lehman (1979), was considered as an indeterminate trematosaurid by several authors (for a summary see Steyer, 2002). Steyer (2002) also suggested that *T. madagascariensis* might be a juvenile individual of *Trematosaurus brauni* - the differences between the two species possibly being linked to the immaturity of the Malagasy specimens - but he retained the former as a distinct species, pending a systematic review of the material. Steyer (2002) considered *Tertremoides ambilobensis* as an invalid taxon, diagnosed on characters (e.g., non-confluent infra and supra-occipital sensory-line grooves, comparatively large orbits, ornamentation lacking tubercles, concave occipital margin of the skull) that vary in relation to the ontogenetic stage (see also Steyer, 2000), and therefore possibly representing a late juvenile of *Trematosaurus madagascariensis* or an early juvenile of *Trematosaurus brauni* (if *T. madagascariensis* is really a juvenile of *Trematosarus brauni*).

More recently, Schoch (2006) concurred with Schoch & Milner (2000) in recognizing *Tertremoides madagascariensis* as the only valid species. The results of his phylogenetic analysis of trematosaurid, which takes into account also the ontogenetic problem in coding character states, show that *Tertremoides madagascariensis* is more derived and well distinct from *Trematosaurus brauni*, and shows close affinities with *Trematolestes hagdorni* from the Middle Triassic of Germany (younger in Age).

Here we describe a new partial skull representing the first Malagasy non-*Wantzosaurus* trematosaurid specimen that preserves, exposed in palatal (ventral) view, the portion of the palate comprised between the posterior margin of the anterior palatal vacuities and the anterior margin of the subtemporal fenestra. This allows us to deepen the knowledge of the anatomy of the Malagasy trematosaurids and to further investigate their questioned taxonomic and phylogenetic affinities.

Material and methods

The specimen is catalogued in the Vertebrate Palaeontological Collection of the Museo di Storia Naturale di Milano (acronym MSNM V) under the number MSNM V2993. The specimen, preserved as a natural mould in a non-calcareous, siliceous, sub-triangular nodule split open in two halves (Fig. 1), has been casted in negative with elastomer for the study. The morphological characters described below refer to this cast, which is a faithful representation of the original skeletal anatomy. Due to this kind of preservation, however, no information about labyrinthine infolding as well as pulp cavities of the preserved teeth is available. The nodule was sampled on surface by local collectors in the 1990's. It is reported from the right bank of the Ifasy River, few kilometres NE to the Anaborano village, Ankitokazo Basin (Besairie, 1972), Ambilobe region, Diégo Suarez Province, Northwestern Madagascar (Fig. 2) (see Maganuco *et al.*, in press, for more details on the locality and faunal assemblage). According to the frequent associated occurrence of the conchostracan *Eustheria* (*Magniestheria*) *truempyi* - also known in the Bernburg Formation, lowermost Olenekian of Germany - in the nodules coming from the Ankitokazo Basin, both specimen studied and other Malagasy trematosaurid material listed above can be generally referred to the Olenekian (Yanbin *et al.*, 2002), 249.7 - 245 MA following the ICS stratigraphy (Gradstein *et al.*, 2004), and not to the Induan as previously reported (e.g., Schoch & Milner, 2000), pending other stratigraphic markers and lacking more complete stratigraphic and geological data.
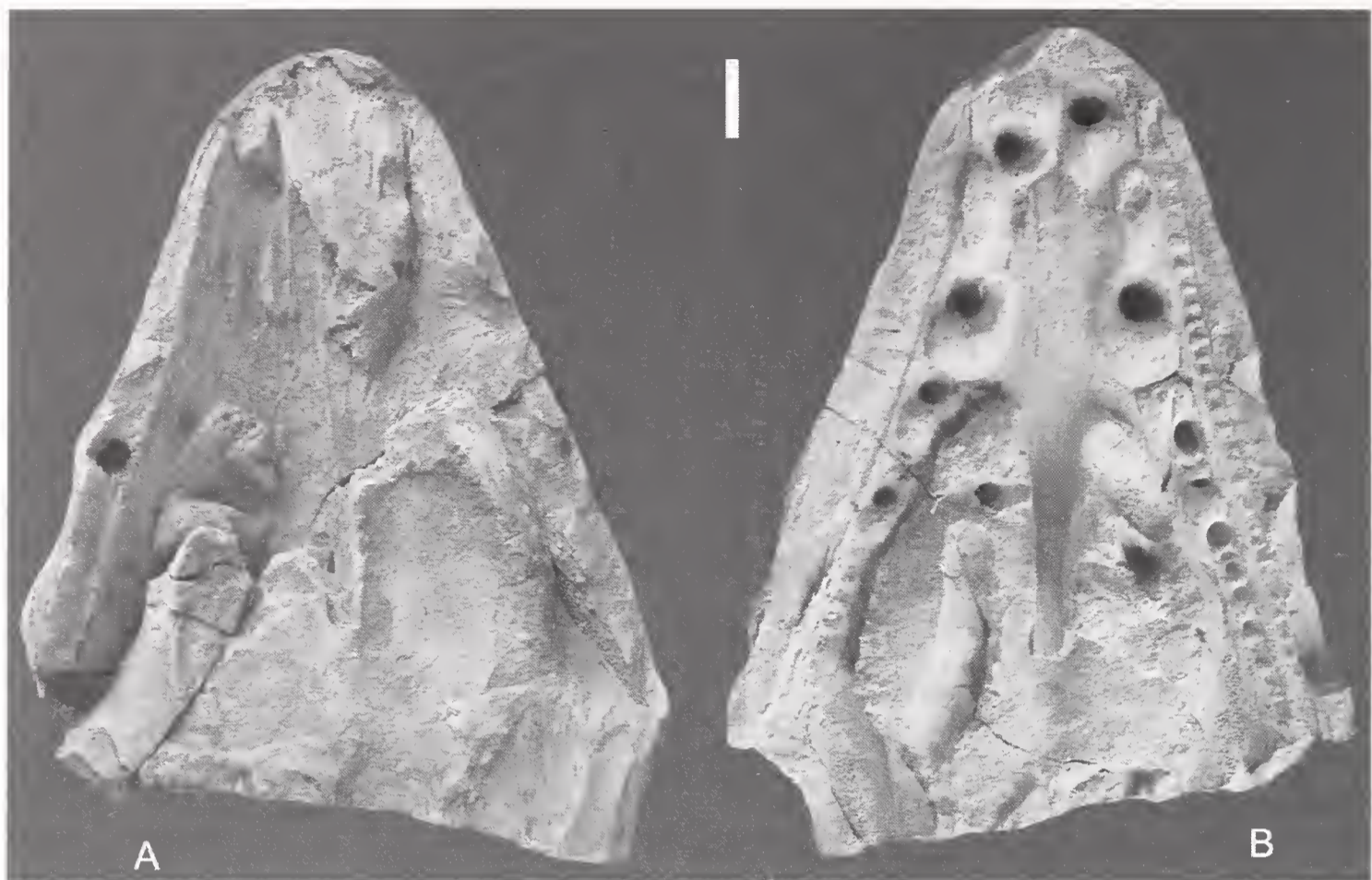
Fig. 1 - Photographs of the specimen MSNM V2993. The nodule, split open, shows the natural mould of the ventral surface of both skull roof (A) and palate (B) of a trematosaurid partial skull. Scale bar equals 20 mm. (Photographs by SM). / Foto dell'esemplare MSNM V2993. Il nodulo, aperto a metà, contiene l'impronta naturale della superficie ventrale del tetto cranico (A) e del palato (B) di un cranio parziale di trematosauride. La scala metrica equivale a 20 mm. (Foto di SM).
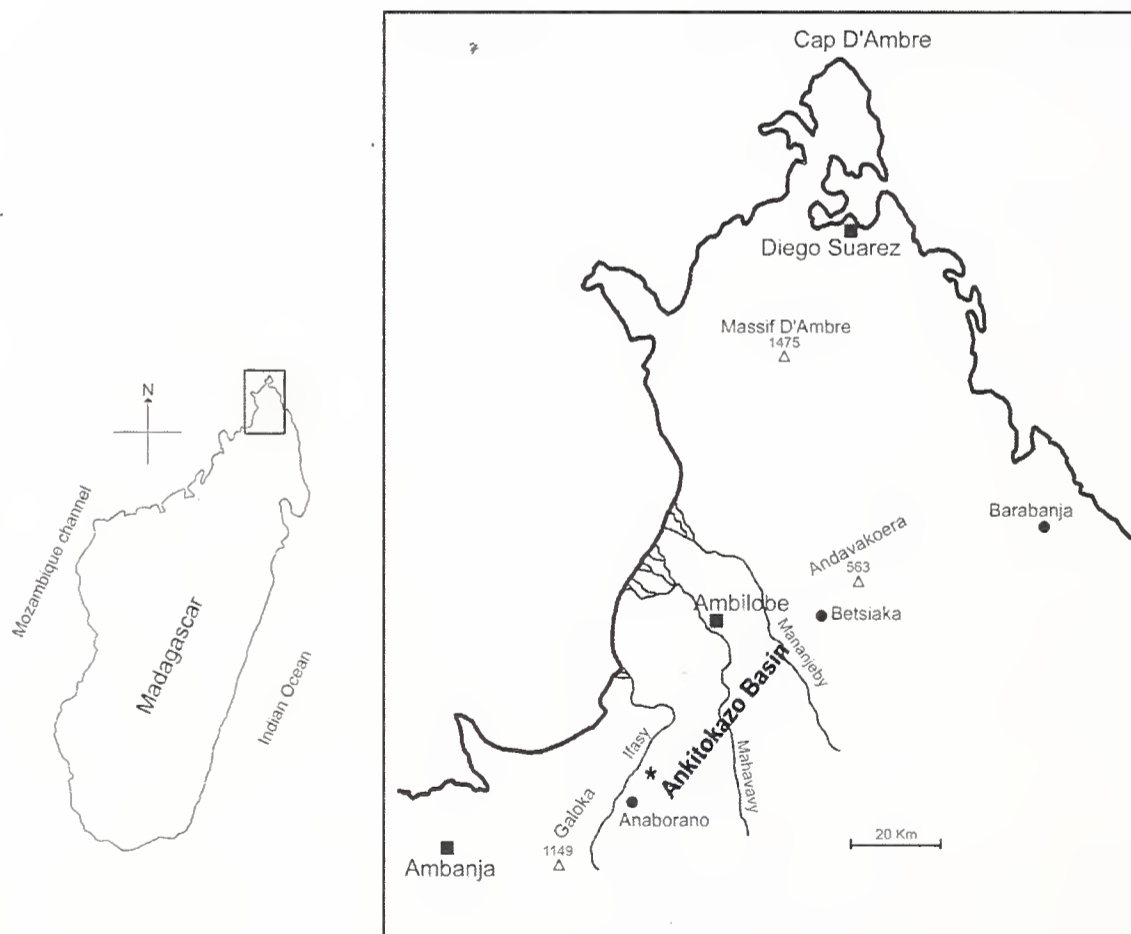
Fig. 2 - Geographic map of Madagascar and close-up of the NW of the island near the village of Anaborano. The main localities and landscape elements cited in the text are shown in the map. The asterisk markes approximatively the area from where the specimen MSNM V2993 was collected. (Drawings by F. Nodo). Fig. 2 - Carta geografica del Madagascar e particolare del nord-ovest dell'isola nei pressi del villaggio di Anaborano, dove sono evidenziati le principali località e i toponimi citati nel testo. L'asterisco indica approssimativamente la zona da cui proviene l'esemplare MSNM V2993. (Disegno di F. Nodo).

Systematic Palaeontology

Temnospondyli Zittel 1887-1890 (*sensu* Milner, 1990)
Stereospondyli Zittel 1887-1890 (emend. Fraas, 1889)
Trematosauridae Watson, 1919
cf. *Tertremoides madagascariensis* (Lehman, 1966) Schoch & Milner, 2000
Figs. 1, 3, 4.
Trematosaurus madagascariensis Lehman 1966, pl. IV B, V B; VI A, B;
Lehman 1979, pl. II A; Janvier, 1992: pl. I, pl. II-1.
Tertremoides ambilobensis Lehman, 1979, fig. 4, pl. III A, B.

Taxonomic remarks - We concur with Schoch & Milner (2000) that comparisons of the cranial material from the Early Triassic of NW Madagascar previously referred to the genera *Tertremoides* and *Trematosaurus* (see introduction) do not reveal significant differences within those taxa; on the basis of the present knowledge, there is no evidence for the occurrence of more than one monospecific genus of trematosaurids other than *Wantzosaurus elongatus*. Following Schoch & Milner (2000; see introduction), *Tertremoides madagascariensis* is the only species we regard as valid and to which the above listed material must be referred, pending new more complete material and a redescription of Lehman's specimens. Therefore, we cautiously refer to this taxon the new specimen MSNM V2993 as well as the snout tentatively referred by Lehman (1979: figs. 1, 2; pl. I A, B) to *Tertrema* (see discussion).

Description and comparisons

The specimen MSNM V2993 represents an incomplete, sub-triangular, and narrow skull, 177 mm long and 120 mm wide, lacking the tip of the snout and most of the postorbital region. It is one of the largest trematosaur specimens found up to today in Madagascar, comparable in size to the large specimen MNHN MAE 3045 figured by Janvier (1992).

Skull roof (Fig. 3) - MSNM V2993 exposes the ventral surface of the skull roof. For this reason, no details of the skull roof external ornamentation can be seen, and only possible traces of the lateral-line system are visible. The bone surface is worn and damaged, rendering impossible to clearly identify the cranial sutures with the exception of few short traits. Therefore, most of the description of the skull roof is focussed on general outline, cranial openings, and preservation.

The antorbital portion of the skull is mostly incomplete on the left side. The left nasal, as well as bones and structures anterior to it, are almost entirely missing, giving insight to the dorsal aspect of the palate below. A large, unidentified, worn bone is juxtaposed on the skull roof bones just anterior to the left orbit, obscuring contacts between jugal, lacrimal, and maxilla. Anterior to this unidentified bone, a sub-triangular fragment of the left maxilla, 31 mm long, is exposed, whereas medially part of the prefrontal-frontal complex can be seen. The missing portion of the snout medial to the right maxilla renders it possible to observe the choana in dorsal view. An incised groove preserved in the same position on both sides of the skull roof can be tentatively interpreted as part of the infraorbital sulcus of the lateral-line system. It is almost straight, 1 mm deep, and 2 mm wide, and it is preserved for no more than 30 mm. Two portions of another possible sulcus, interpreted as the supraorbital one, are preserved on the right side of the skull: the anterior portion is located medial to the infraorbital sulcus, and it is straight, 31 mm long, 2 mm wide, and 1 mm deep; the posterior portion parallels the posterior half of the medial margin of the orbit, and it is about 20 mm long, 2 mm wide, and very shallow.
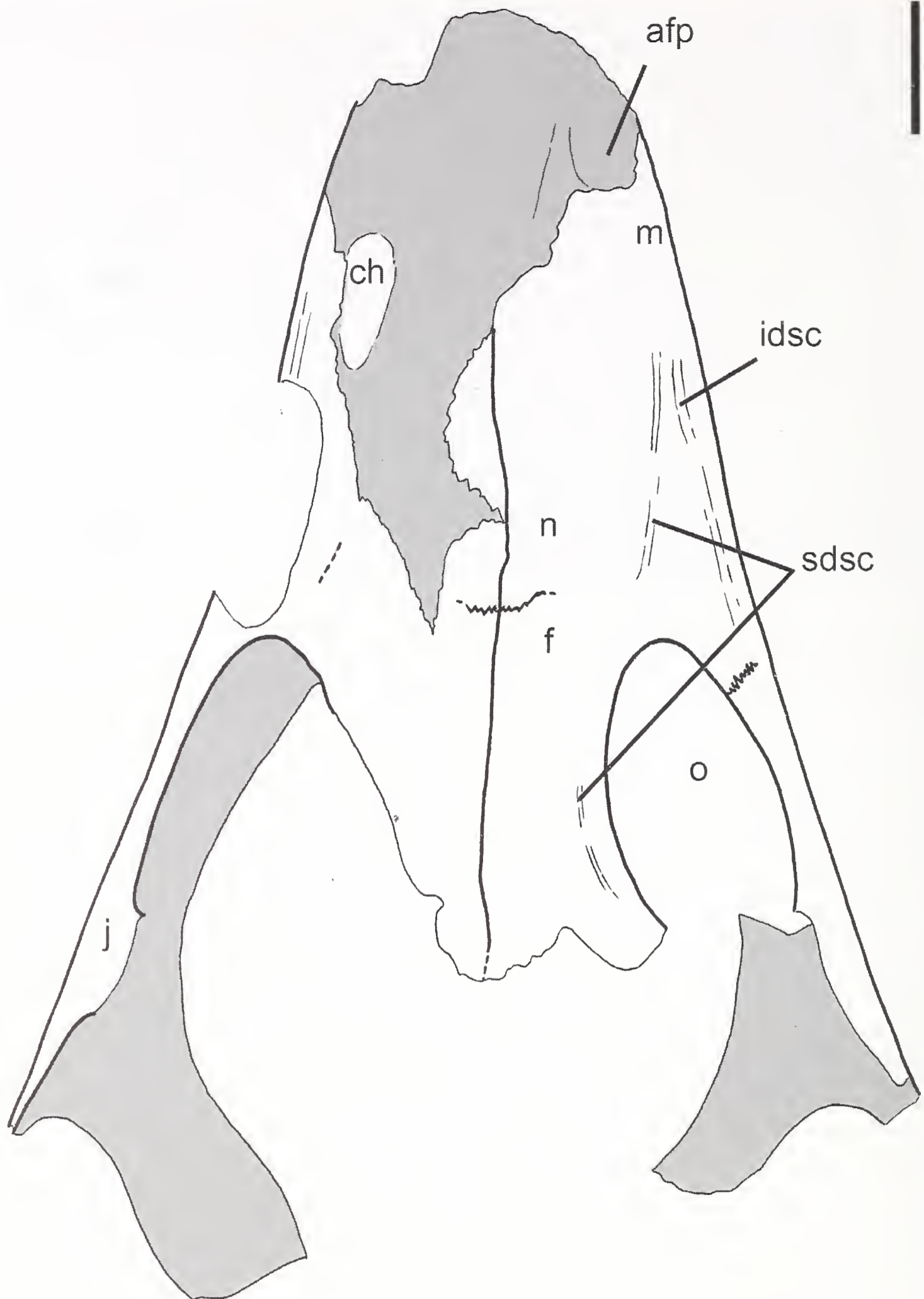
Fig. 3 - Interpretative line-drawing of the specimen MSNM V2993 in dorsal view. Anatomical abbreviations: afp) air-flow passage; ch) choana; f) frontal; idsc) infraorbital dermosensory canal; j) jugal; m) maxilla; n) nasal; o) orbit; sdsc) supraorbital dermosensory canal. Scale bar equals 20 mm. (Drawing by SM).

Fig. 3 - Disegno interpretativo dell'esemplare MSNM V2993 in norma dorsale. Abbreviazioni anatomiche: afp) condotti per il passaggio dell'aria; ch) coana; f) frontale; idsc) canale dermosensoriale infraorbitale; j) giugale; m) mascellare; n) nasale; o) orbita; sdsc) canale dermosensoriale sopraorbitale. La scala metrica equivale a 20 mm. (Disegno di SM).

The snout of MSNM V2993 is more complete on the right side. The right nasal is the most distinguishable element, although its sutures with the neighbouring bones can be only hypothesized. It measures 51 mm in length, and we estimate that it is preserved up to few millimetres posterior to the posterior margin of the naris. Anterior to the anterior broken margin of the nasal, the air-flow passage that united the naris to the choana can be seen on the dorsal surface of the palate. The inferred position of the naris, few millimetres anterior to the broken margin of the nasal, is supported by the condition seen in other similar trematosaurids such as *Tertrema acuta* (Wiman, 1917), *Trematosaurus brauni* (Schoch & Milner, 2000), the Malagasy snout referred to *Tertrema* by Lehman (1979), and *Trematolestes hagdorni* (Schoch, 2006): they show close proximity or superimposition of the posterior margin of the naris respect to the anterior portion of the vomer and its large vomerine tusks.

A roughly transverse, 11 mm long, denticulated portion of the nasofrontal suture is visible, crossing the midline of the skull just anterior to the level of the anterior margin of the orbits, and indicating that in MSNM V2993 the frontals are not as anteriorly extended as they are in *Trematosaurus brauni* (Schoch & Milner, 2000: fig. 77), *Trematosaurus madagascariensis* (e.g., Lehman, 1979: fig. 3), and *Trematolestes hagdorni* (Schoch, 2006: fig. 7), or as they are reconstructed in *Tertremoides ambilobensis* (Lehman, 1979: fig. 4). The posterior extension of both frontals and postfrontals cannot be evaluated, pending their posterior portions. Structures usually visible on the ventral surface of the skull roof, such as the supraorbital laminae, are not apparent on the preserved portion of the frontals. Similarly, the contacts between prefrontal, frontal, and postfrontal cannot be detected on both sides.

Most of the jugals are preserved, with a reconstructed length of about 72 mm: the right one shows parts of its anterior sutural margin with the prefrontal; the left one is almost complete, preserved posteriorly up to the level of the subtemporal fenestra. The portion lateral to the orbit is only 5 mm in depth, the orbits being close to the lateral margin of the skull and the skull roof being rather flat.

In combining information from both orbits, orbital shape can be reconstructed and the length of the orbital diameters estimated. The right orbit lacks the posterior portion but preserves the anterior margin and most of the lateral and medial ones (mediolateral diameter equals 25 mm). The left orbit is less complete but the orbital contribution of left jugal is entirely preserved, allowing to estimate where the lateral margin turned upwards to form the posterior margin and, consequently, the length of the longer axis (about 40 mm long). The reconstructed orbits, facing dorsolaterally, are oval in shape, with the longer axis parallel to the lateral margins of the skull, and are located at the level of the anterior half of the interpterygoid vacuities. The orbits appear also relatively large in size with a comparatively low interorbital distance: the distance between the medial margin of the orbit and the median sagittal plane of the skull is less than the maximum mediolateral diameter of the orbit. The orbits of MSNM V2993 are larger and closer to the midline than those of *Trematosaurus madagascariensis* (Lehman, 1979) and *Tertrema acuta* (Wiman, 1917), and even more than those of *Trematosaurus brauni* (Schoch & Milner, 2000); in both size and distance, they match those of *Tertremoides ambilobensis* (Lehman, 1979) and of the large, adult specimen of *Trematolestes hagdorni* (Schoch, 2006); they are smaller and more separated from each other than those of the juvenile specimen of *Trematolestes hagdorni* (Schoch, 2006). Some indeterminate, displaced, poorly preserved, and large bones are visible within the left orbital cavity.

Palate (Fig. 4 A) - Although incomplete, the palate of MSNM V2993 is preserved better than the skull roof, rendering it possible recognition of many anatomical features and detailed comparisons with known trematosaurid palates. The preserved lateral margins of the skull of MSNM V2993 are straight in outline, without the change in curvature at the level of the choane (reducing the degree of convergence of the two maxillae before their contacts with the premaxillae) visible in *Tertrema acuta* (Wiman, 1917), *Hyperokinodon keuperinus* (Hellrung, 1987), and *Trematolestes hagdorni* (Schoch, 2006).

The snout is incomplete, truncated anteriorly at the level of the posteromedial borders of the anterior palatal vacuities. As a consequence, the premaxillae are almost entirely missing, with the exception of few millimetres of their ventral surfaces, preserved on both sides, just anterior to the suture with the maxilla. The choanae are sub-oval and elongate, although not so much elongated as in *Tertrema acuta* (Wiman, 1917), and do not appear particularly large. In size and shape they resemble those of *Trematosaurus brauni* (Schoch & Milner, 2000). Each choana is bordered by the vomer anteromedially, by the maxilla laterally, and by the palatine posteriorly. The vomers are almost complete, with a vomerine plate considerably longer than wide. Anteriorly, they form the posterior, rounded borders of the anterior palatal vacuities and, via a narrow process, the preserved medial borders too. In MSNM V2993, this narrow anterior process of the vomers is only slightly wider than the posterior margin of each anterior palatal vacuity. It is similarly narrow in the Malagasy snout referred to *Tertrema* by Lehman (1979), whereas it is markedly wider in *Trematosaurus brauni* (Schoch & Milner, 2000), *Tertrema acuta* (Wiman, 1917), *Hyperokinodon keuperinus* (Hellrung, 1987), and *Trematolestes hagdorni* (Schoch, 2006), in which it results about as wide as the two vacuities.

Anterior to the choanae, each vomer extends laterally up to the maxillary tooth row and bears a couple of very large, rounded, anteroposteriorly aligned sockets for the vomerine tusks; only the right anterior and the left posterior sockets are actually occupied by vomerine tusks (preserved as asymmetrical holes in Fig. 1). These big tusks, up to 16 mm tall, are conical and finely striated apicobasally. A pair of vomerine teeth as large as the maxillary ones is also present, located parallel to the choana and more clearly visible on the left side. A row of vomerine teeth parallel to the choana has been figured also in *Trematosaurus brauni* (Schoch & Milner, 2000: fig. 77). Large vomerine tusks are present also in *Trematolestes* (Schoch, 2006), *Tertrema* (Wiman, 1917), *Hyperokinodon keuperinus* (Hellrung, 1987), and *Trematosaurus brauni* (Schoch & Milner, 2000), although in the latter they are not as wide as in the other three taxa mentioned and in MSNM V2993. The denticulated suture between the vomers and the palatines can be traced with continuity only at the anterior and posterior extremities, close to the choanae and the interpterygoid vacuities respectively. The vomers extend posteriorly forming a sub-rectangular process that borders the anterior trait of the medial side of the interpterygoid vacuities. This process, apparently comparable in length with one figured by Wiman (1917) in *Tertrema acuta* and shorter than those of the other trematosaurids such as *Trematosaurus brauni* (Schoch & Milner, 2000), underplates the anterior portion of the cultriform process of the parasphenoid.

The cultriform process of the parasphenoid of MSNM V2993 has parallel lateral margins and is posteriorly preserved up to the level of the suture between the anterior branch of the pterygoid and the ectopterygoid. Interestingly, the cultriform process of MSNM V2993 shows features uncommon in the other trematosaurids: the preserved
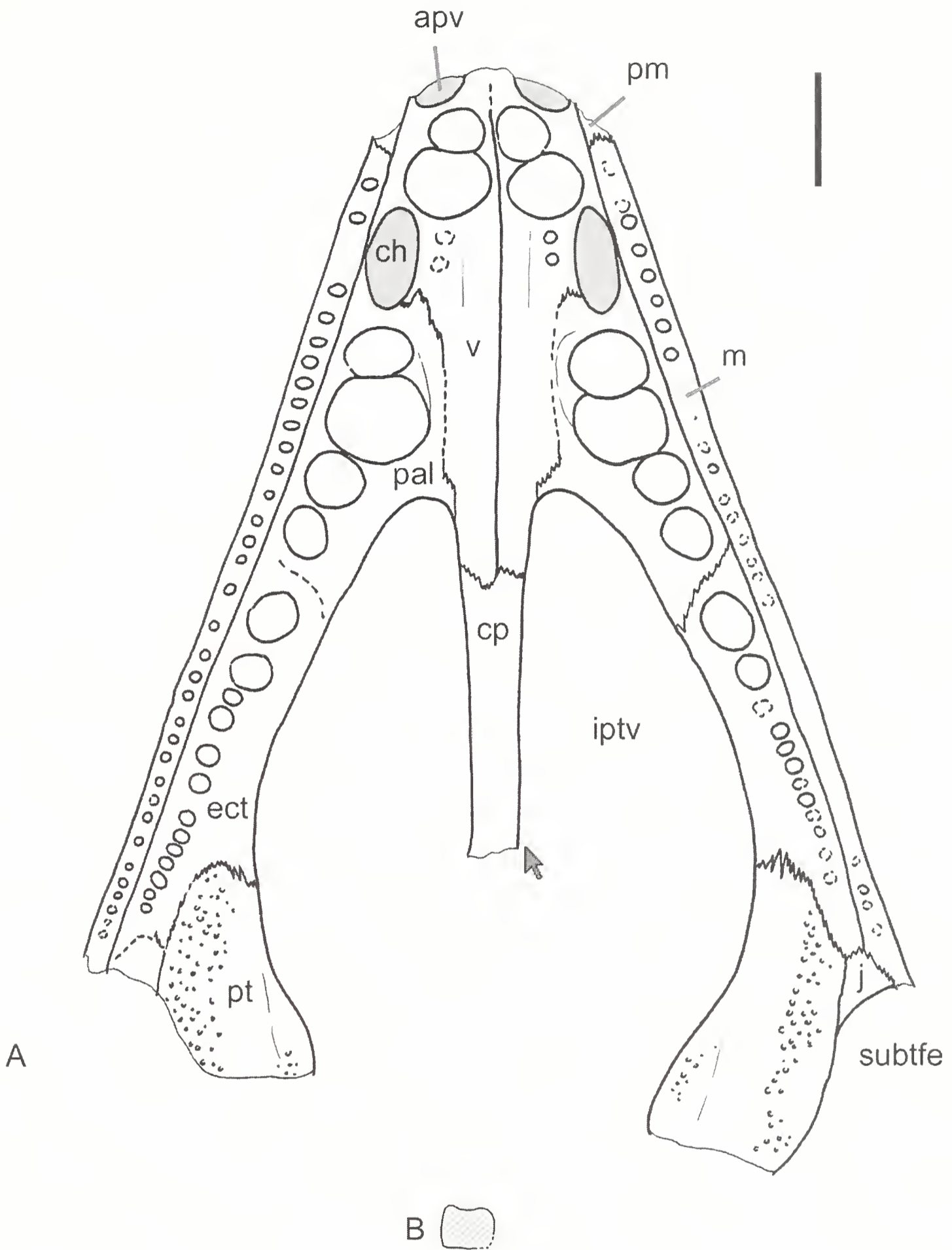
Fig. 4 - Interpretative line-drawing of the specimen MSNM V2993 in palatal view (A), and cross section of the cultriform process of the parasphenoid (B). The grey arrow in (A) indicates at which level of the cultriform process the cross section in (B) was drawn. Anatomical abbreviations: apv) anterior palatal vacuity; ch) choana; cp) cultriform process of the parasphenoid; ect) ectopterygoid; iptv) interpterygoid vacuity; j) jugal; m) maxilla; pal) palatine; pm) premaxilla; pt) pterygoid; subtfe) subtemporal fenestra; v) vomer. Scale bar equals 20 mm. (Drawings by SM).

Fig. 4 - Disegno dell'esemplare MSNM V2993 in norma palatale (A) e sezione trasversa del processo cultriforme del parasfenoide (B). La freccia grigia in (A) indica a che altezza del processo cultriforme è stata disegnata la sezione trasversa in (B). Abbreviazioni anatomiche: apv) vacuità palatale anteriore; ch) coana; cp) processo cultriforme del parasfenoide; ect) ectopterigoide; iptv) vacuità interpterigoidea; j) giugale; m) mascellare; pal) palatino; pm) premascellare; pt) pterigoide; subtfe) finestra subtemporale; v) vomere. La scala metrica equivale a 20 mm. (Disegni di SM).

portion is flat ventrally and squared in cross section (as suggested by Warren, 1998, for *Tertremoides ambilobensis*), as shown by the cross-sectional view of the broken posterior margin (Fig. 4 B), without any trace of the ventral keel recognized as a trematosaurid synapomorphy in recent phylogenetic reviews of the group (e.g., Steyer, 2002; Damiani & Yates, 2003; Schoch, 2006); the process is relatively wide, about twice the width of the mediolateral diameter of the dentigerous surface of the maxilla, whereas it is as wide as this surface in *Trematosaurus brauni* (Schoch & Milner, 2000), *Tertrema acuta* (Wiman, 1917), and *Trematolestes hagdorni* (Schoch, 2006).

Both palatines are well preserved and are similar in shape to those of *Trematosaurus brauni* (Schoch & Milner, 2000), the main difference consisting of size and number of palatine tusks and teeth: in MSNM V2993 the palatine dentition indeed consists of a row of four anteroposteriorly aligned large sockets bearing tusks (the first and the fourth sockets are still occupied by tusks on the right palatine, the first and the third on the left one), the first two extremely large (with tusks up to 16 mm in reconstructed height) and similar in size and shape to those borne by the vomers; in *Trematosaurus brauni* each palatine tooth row is composed by a total of six sockets, the first two hosting large tusks, the following four hosting teeth as large as or slightly larger than the maxillary teeth (Schoch & Milner, 2000: fig. 77). There are seven sockets in *Trematolestes hagdorni*, in which there is an additional tooth (Schoch, 2006: fig. 4 B). Four, possibly five, sockets, with two large tusks followed by two small tusks and a tooth as large as the maxillary ones lateral to the choana, seem to be present in *Tertrema acuta* but bone sutures are difficult to be seen in the image published by Wiman (1917: pl. XII).

In MSNM V2993, the denticulated suture between the palatine and ectopterygoid, well visible on the left side, is posteromedially directed at an angle of 60° respect to the tooth row and measures 20 mm in length. The right and left ectopterygoid are also entirely preserved, each one bearing a tooth row that is parallel to the maxillary tooth row and is in continuity with the palatine ones. The ectopterygoid tooth row consists of two tusks slightly smaller than the preceding palatine ones followed by several teeth, at least 14 on the right side, sub-circular in cross section and decreasing in size (from 4 to 2 mm in socket diameter) towards the posterior end of the row, where they match the size of the maxillary teeth. In *Trematosaurus brauni* the ectopterygoid does not bear tusks and the teeth are more than 20 in number (Schoch & Milner, 2000). A pair of tusks followed by 15 teeth are present in *Trematolestes hagdorni* (Schoch, 2006). At least one large tusk and more than 10 large teeth are present in *Tertrema acuta* (Wiman, 1917).

Aside from the tooth size and number, another difference regards the relative length of the ectopterygoid. In MSNM V2993 the ectopterygoid is as long as the vomerine plate (about 70 mm), as is the case in *Trematolestes hagdorni* (Schoch, 2006) and probably in *Tertrema acuta* (Wiman, 1917); it appears relatively shorter than that of *Trematosaurus brauni*, where it is almost twice the length of the vomerine plate (Schoch & Milner, 2000: fig. 77). The different relative length of the palate between MSNM V2993 and *Trematosaurus brauni* is suggested also by the interpterygoid vacuities, that, although similar in the general shape ("D" - shaped; see Fig. 4 and Schoch & Milner, 2000: fig. 77), appear considerably more stretched anteroposteriorly in the latter.

Of both pterygoids, only part of the anterior branch is preserved, and it has a granular ventral surface. The anterior branches seem to inflate mediolaterally towards their posteriormost preserved portion, forming a slightly convex medial

margin, and interrupting the regular, concave curvature of the lateral surface of the interpterygoid vacuities. This pattern is visible also in dorsal view.

A small portion of the left jugal appears as a wedge between the anterior branch of the pterygoid, the ectopterygoid, and the maxilla. As in *Trematosaurus brauni*, it borders the anterior margin of the subtemporal fenestra. The posteriormost tips of the maxillae bordering the anterolateral corner of the subtemporal fenestrae are missing, but, in all likelihood, the entire maxillary tooth row is preserved, more clearly visible on the right element. Unfortunately, only the empty sockets of the maxillary teeth are preserved: they are sub-circular in cross section, only slightly more compressed anteroposteriorly lateral to the palatines. Their diameters range from 2 to 2.5 mm. Numerous and delicate maxillary teeth are indicated by Schoch (2006) as a derived character shared by *Trematolestes hagdorni*, *Tertremoides madagascariensis*, and the lonchorhynchine trematosaurids. In MSNM V2993, the separation between the maxilla and the palatal elements medial to it is marked by a shallow longitudinal groove. This groove separates the maxillary tooth row from the palatal tooth row, possibly accommodating the tip of the teeth of the dentary tooth row, when the jaws closed (see Palaeobiology).

Discussion

Taxonomic affinities - MSNM V2993 certainly does not belong to *Wantzosaurus elongatus*, the latter having: more elongate interpterygoid vacuities with orbits more posteriorly retracted respect to them and considerably longer frontals and nasals already in juveniles; palatine that seems to be excluded from the interpterygoid vacuity by contact between a posterior process of the vomer and the ectopterygoid; palatine bearing two tusks only; vomerine plate bearing only one tusk and no tooth or denticle medial to each choana; a cultriform process of the parasphenoid that is definitely knife-edged.

In spite of the limited amount of possible direct comparisons within MSNM V2993 and the other trematosaurian specimens from Madagascar, the comparable anatomical features are consistent with the assignment of MSNM V2993 to *Tertremoides madagascariensis*, the only other Malagasy species we regarded as valid. As a matter of fact, size, shape, position, and orientation of the orbits, the inferred distance between orbits and nares, and skull outiline and proportions in MSNM V2993 well match the scheme shown by other specimens of *Tertremoides madagascariensis*. The same combination of features renders weaker a possible attribution of MSNM V2993 to either *Tertrema*, or *Trematolestes*, or *Trematosaurus,* or the poorly known *Hyperokynodon*. Only the anterior extension of the frontals seems to be less in MSNM V2993 than in known specimens of *Tertremoides madagascariensis* but it must be taken into account that the nasofrontal suture has been only tentatively identified in the former, and clearly reported in only one specimen of the latter (Lehman, 1979: fig. 3).

Further comparisons between MSNM V2993 and other trematosaurids are made looking at the palate, although some palatal features of *Tertrema acuta* are poorly known and most of the palatal anatomy of *Trematolestes hagdorni* is from juvenile individuals (Schoch, 2006): MSNM V2993 resembles *Trematosaurus brauni* in size and shape of the choanae and in having a tooth row parallel to the choana - a plesiomorphic character according to Schoch (2006); MSNM V2993 resembles both *Tertrema acuta* and *Trematolestes hagdorni* in the ectopterygoid proportions

and in having very large vomerine tusks; MSNM V2993 resembles *Tertrema acuta* in having a short posterior process of the vomers underplating the cultriform process of the parasphenoid, and in having 4 palatine tusks (followed by a tooth in the latter); MSNM V2993 resembles *Trematolestes hagdorni*, *Tertremoides madagascariensis*, and the lonchorhynchine trematosaurids in having small, numerous, delicate maxillary teeth; finally, MSNM V2993 resembles *Trematolestes hagdorni* in size and number of ectopterygoid tusks and teeth.

The specimen MSNM V2993 differs from *Tertrema acuta, Trematolestes hagdorni*, and *Trematosaurus brauni* in having a considerably narrower anterior process of the vomers, and a wider cultriform process with a flat ventral surface and without any trace of ventral keel. As mentioned above, a knife-edged and narrow cultriform process has been recognized as a trematosaurid synapomorphy in recent phylogenetic reviews of the group (e.g., Steyer, 2002; Damiani & Yates, 2003; Schoch, 2006). Therefore, the plesiomorphic state shown by MSNM V2993 may eventually represent either a plesiomorphic trait, or an autapomorphic reversion occurred only in this Malagasy taxon (see description).

In conclusion, MSNM V2993 shows more affinities with *Tertrema acuta* and *Trematolestes hagdorni* than *Trematosaurus brauni* (albeit some affinities are found with the latter), and some peculiar features unreported in trematosaurids. This combination of features demonstrates the presence of - at least - one Malagasy trematosaurid genus clearly distinct from the long-snouted *Wantzosaurus* in the fauna, and not referable either to *Trematosaurus* or to other genera known outside Madagascar.

In our opinion, the Malagasy snout assigned by Lehman (1979: figs. 1, 2; pl. I A, B) to *Tertrema* should not be referred to this genus. Like the holotype of *Tertrema*, that Malagasy specimen has indeed a truncated tip of the snout, very large and elongate anterior palatal vacuities, and a depression on the posterior median process of the premaxillae (Lehman, 1979); however, it differs from *Tertrema* (Wiman, 1917) in having more rounded lateral margins of the snout, considerably less elongate nares, and, above all, for its peculiar, large premaxillary teeth, one of which located above the interpremaxillary suture. This peculiar tooth arrangement is not present in the other trematosaurid taxa considered in this study, although two large teeth are present in the tip of the snout of *Trematolestes* and teeth becoming progressively larger towards the anterior portion of the snout were described and figured by Lehman (1966: pl. VI A, B) for *Tertremoides madagascariensis*. A truncated tip of the snout is present, for example, also in *Trematosaurus brauni*, and large vomerine sockets are present in *Trematosaurus brauni*, *Tertrema acuta*, *Trematolestes hagdorni*, and MSNM V2993. Therefore, in our opinion Lehman's Malagasy snout should be assigned neither to *Tertrema* nor to *Trematosaurus* nor to *Trematolestes*. Rather, the few comparable features between Lehman's specimen and MSNM V2993 (e.g., narrow anterior median vomerine process, size and number of tusks) suggest that they may belong to the same taxon.

The only other, possibly non-lonchorhynchine trematosaurid palate from Madagascar is the specimen figured by Lehman (1961: pl. III E) and referred to an indeterminate trematosaurian. Comparisons between this specimen and MSNM V2993 cannot be made, because the former consists of more posterior elements (incomplete pterygoids and a parasphenoid plate with the posterior portion of the cultriform process) and, moreover, it is preserved in dorsal view.

Phylogenetic affinities - A phylogenetic analysis of stereospondylomorphs, based on 45 taxa and 86 cranial and mandibular characters, was conducted by Maganuco *et al.* (in press). That analysis was focussed on the affinities of the capitosaur *Edingerella madagascariensis* but included the main lineages of stereospondyls. From that study, we borrow the character descriptions and the data matrix. The present study is focussed on the phylogenetic position of both MSNM V2993 and non-Lonchorhynchinae Malagasy trematosaurids within the Trematosauria. For this reason, we add the following 9 operative taxonomic units (source see Appendix 1; codings see Appendix 2) for a total of 54 terminal taxa: the new specimen MSNM V2993; the Malagasy trematosaurid snout described by Lehman (1979) and referred by him to the genus *Tertrema*; the Malagasy species *Trematosaurus madagascariensis* and *Tertremoides ambilobensis* (coded separately, to test their synonymy); and further five species of trematosaurids, *Aphaneramma rostratum*, *Cosgriffius campi*, *Lyrocephaliscus euri*, *Platystega depressa*, and *Tertrema acuta*. The final data matrix, compiled in NDE (Page, 2001), was analyzed using the heuristic search of the most parsimonious tree (MPT) of PAUP 4.0b10 (Swofford, 2002). Character transformation was optimized under both accelerated transformation (ACCTRAN) and delayed transformation (DELTRAN) options of PAUP. The analysis generated 420 most parsimonious trees (MPTs), requiring 517 steps, and giving a consistency index (CI) of 0.2263, a retention index (RI) of 0.6444, and a rescaled consistency index (RC) of 0.1458. The majority-rule consensus tree of the 420 MPTs is illustrated in Fig. 5. The discussion below is based on this consensus tree, and the 'tree description' option of PAUP was used to obtain the reconstructed states for internal nodes (Tab. 1), based on one of the MPTs showing a topology identical to that of the majority-rule consensus tree. A detailed investigation of the non-trematosaurian stereospondyl interrelationships is beyond the scope of this study. Relationships between the non-trematosaurian taxa are discussed in Maganuco *et al.* (in press) and will be discussed in more details elsewhere (Maganuco *et al.*, in prep.). We note, however, that the addition of several trematosaurid terminal taxa did not affect the global tree topology obtained by Maganuco *et al.* (in press), the main difference consisting of the position of *Lapillopsis*, *Lydekkerina*, *Chomatobatrachus*, and *Deltacephalus*: in the present analysis, these taxa are found to be basal to the short-faced stereospondyl clade and not strictly related to the Capitosauria + Trematosauria; on the contrary, in Maganuco *et al.* (in press) *Lapillopsis* is a basal stereospondyl, whereas the other three taxa are successive sister taxa of the Capitosauria + Trematosauria and not strictly related to the short-faced stereospondyl clade.

As regards trematosaurs, the present analysis suggests that MSNM V2993, the Malagasy snout referred to *Tertrema* by Lehman (1979), and the remains assigned so far to *Tertremoides ambilobensis* or *Trematosaurus madagascariensis* may well have pertained to a single species, *Tertremodies madagascariensis sensu* Schoch & Milner (2000), pending a detailed revision of Lehman's material housed at the Muséum national d'Histoire naturelle, Paris, France. The group consisting of this possibly monospecific Malagasy non-Lonchorynchinae material is closely related to the German species *Trematolestes hagdorni*, forming the '*Trematolestes* clade' of Schoch (2006). It is noteworthy that in some of the MPTs, *Trematolestes hagdorni* results alternatively the sister taxon of one of the Malagasy specimens/species: this is probably linked to the fact that the Malagasy specimens/species are poorly known in many characters. Therefore, relationships within the '*Trematolestes* clade'

can not be well elucidated, based on the phylogeny only. The topology in Fig. 5, showing *Trematolestes hagdorni* as sister taxon of a monophyletic Malagasy material, is, however, the most likely, taking into account also the taxonomic affinities discussed above and the geological/stratigraphical context. As in Schoch (2006), the '*Trematolestes* clade' is nested within the slender-headed trematosaurs but, contrary to that author, among these it is more closely related to *Tertrema acuta* than to the lonchorhynchine trematosaurids. The Lonchorhynchinae as represented here form a monophylum with *Aphaneramma rostratum* as the basalmost member. The internal relationships differ from those found by Schoch (2006), in which *Wantzosaurus elongatus* is the basalmost of the three taxa. However, as noted by Schoch (2006), relationships within the Lonchorhynchinae can be affected by the fact that *Aphaneramma rostratum* is poorly known in many characters. *Lyrocephaliscus euri*, *Trematosaurus brauni*, and *Platystega depressa* are stem-taxa of the recognized monophylum of slender-headed trematosaurs, forming an unresolved politomy in the strict consensus tree. According to the majority-rule consensus tree in Fig. 5, the former species would be the most basal of the three species, whereas the latter one would be the most derived. *Angusaurus* and *Thoosuchus yakovlevi* are found to be basal Trematosauroidea (*sensu* Yates & Warren 2000, i.e., the last common ancestor of *Thoosuchus* and *Trematosaurus brauni* and all its descendants), with the latter being the most basal of the two. We follow Yates & Warren (2000) redefining the Trematosauria Romer, 1947 as all stereospondyls sharing a more recent common ancestor with *Trematosaurus* than with *Parotosuchus*. Our Trematosauria is therefore formed by *Benthosuchus sushkini* plus the Trematosauroidea, and results the sister taxon of the Capitosauria (we follow Damiani & Yates, 2003 redefining the Capitosauria Yates & Warren, 2000 as all stereospondyls sharing a more recent common ancestor with *Parotosuchus* than with *Trematosaurus*).

Systematic assignment - As mentioned, in Schoch's (2006) phylogeny *Trematolestes hagdorni* is the sister taxon of *Tertremoides madagascariensis*: they plus the Lonchorynchinae form the sister taxon of *Tertrema acuta*, whereas *Trematosaurus brauni* is a basal trematosaurid not strictly linked with the Malagasy taxon, as formerly recognized by Schoch & Milner (2000). The phylogenetic affinities within *Tertremoides madagascariensis* and the other trematosaurids as found by Schoch

Fig. 5 - Majority-Rule consensus tree of 420 MPTs resulting from a phylogenetic analysis using software PAUP* Version 4.0b10 (Swofford, 2002) based on the data matrix of Maganuco *et al.* (in press), with nine new OTUs added (sources see Appendix 1; codings see Appendix 2). TL=517 steps, CI=0.2263, RI=0.6444, RC=0.1458. Percentages at nodes are indicated only for groups appearing on less than 100% of the MPTs. Abbreviations: A) Stereospondyli; B) short-faced stereospondyl clade; C) Capitosauria; D) Trematosauria; E) Trematosauroidea; F) slender-headed trematosaurs; G) Lonchorhynchinae; H) '*Trematolestes* clade', *sensu* Schoch, 2006; I) *Tertremoides madagascariensis*, *sensu* Schoch & Milner, 2000.

Fig. 5 - Albero "Majority-Rule consensus" dei 420 alberi più parsimoniosi (MPTs) generati da PAUP* 4.0.b10 (Swofford, 2002) sulla base della matrice dei dati riportata da Maganuco *et al.* (in press), in cui sono state aggiunte nove nuove unità operative tassonomiche (OTUs) (fonti in Appendice 1; codifiche in Appendice 2). TL=517 steps, CI=0.2263, RI=0.6444, RC=0.1458. Le percentuali ai nodi sono indicate solo per quei gruppi che non appaiono nel 100% dei MPTs. Abbreviazioni: A) Stereospondyli; B) clade degli stereospondili a muso corto; C) Capitosauria; D) Trematosauria; E) Trematosauroidea; F) clade dei trematosauri dal muso slanciato; G) Lonchorhynchinae; H) 'clade di *Trematolestes*', *sensu* Schoch, 2006; I) *Tertremoides madagascariensis*, *sensu* Schoch & Milner, 2000.

Quasicyclotosaurus campi
Yuanansuchus laticeps
Eryosuchus garjainovi
Mastodonsaurus giganteus
Eocyclotosaurus
Odenwaldia heidelbergensis
Paracyclotosaurus davidi
Wellesaurus peabodyi
Cherninia denwai
Xenotosuchus africanus
Cyclotosaurus robustus
Tatrasuchus wildi
Stanocephalosaurus pronus
Stenotosaurus stantonensis
Parotosuchus orenburgensis
Wetlugasaurus angustifrons
Watsonisuchus magnus
Watsonisuchus rewanensis
Watsonisuchus gunganj
Edingerella madagascariensis
Warrenisuchus aliciae
Sclerothorax hypselonotus
MSNM V2993
Malagasy 'Tertrema' snout
Tertremoides ambilobensis
Trematosaurus madagascariensis
Trematolestes hagdorni
Tertrema acuta
Cosgriffius campi
Wantzosaurus elongatus
Aphaneramma rostratum
Platystega depressa
Trematosaurus brauni
Lyrocephaliscus euri
Angusaurus
Thoosuchus yakovlevi
Benthosuchus sushkini
Almasaurus habbazi
Koskinonodon perfectus
Metoposaurus diagnosticus krasiejowensis
Compsocerops cosgriffi
Gerrothorax pustuloglomeratus
Laidleria gracilis
Xenobrachyops allos
Keratobrachyops australis
Arcadia myriadens
Deltasaurus kimberleyensis
Chomatobatrachus halei
Deltacephalus whitei
Lydekkerina huxleyi
Lapillopsis nana
Rhineceps nyasaensis
Uranocentrodon senekalensis
Konzhukovia vetusta
A
B
C
D
E
F
G
H
I
75
50
43
26
43
33
67

Tab. 1 - Unambiguous apomorphies, additional apomorphies under delayed character-state optimization (DELTRAN), and additional apomorphies under accelerated character-state optimizazion (ACCTRAN), describing trematosaurian nodes and terminal taxa in Fig. 5. The clade notation used in the Node column, "taxon X + taxon Y", refers to the least inclusive clade in the Majority-Rule consensus tree comprising the two given taxa, and does not imply that these taxa share a direct sister-taxon relationship. Abbreviations, systematic terms, and informal names used in Fig. 5 to define some clades are also indicated in the Node column. The symbol "→" indicates the character-state change occurred.
Tab. 1 - Apomorfie non ambigue, apomorfie addizionali ottenute tramite l'ottimizzazione ritardata dello stato dei caratteri (DELTRAN) e apomorfie addizionali ottenute tramite l'ottimizzazione accelerata dello stato dei caratteri (ACCTRAN) che descrivono i nodi e i taxa terminali di trematosauri visibili in Fig. 5. I cladi sono indicati nella colonna dei nodi tramite la dicitura "taxon X + taxon Y": essa si riferisce al clade meno inclusivo dell'albero di consenso Majority-Rule che comprende i due taxa dati e non implica una diretta relazione di tipo "sister-taxon" tra di essi. Nella colonna dei nodi sono indicati anche le abbreviazioni, i termini sistematici e i nomi informali utilizzati in Fig. 5 per definire alcuni cladi. Il simbolo "→" indica il cambiamento di stato avvenuto ad ogni nodo per ciascun carattere.

Node / terminal taxon	**Unambiguous apomorphies**	**Additional apomorphies (DELTRAN)**	**Additional apomorphies (ACCTRAN)**
Trematosauria + Capitosauria	77 (0→1); 78 (0→1); 81 (0→1).	8 (0→1).	28 (0→1).
D, Trematosauria	3 (0→1); 4 (0→1); 6 (0→1); 9 (0→1); 21 (0→1); 23 (0→1); 24 (0→1); 25 (0→1); 26 (0→1); 45 (0→1); 50 (1→2); 55 (0→2); 68 (0→1).	57 (0→1).	None.
Benthosuchus sushkini	5 (0→2); 7 (0→1); 12 (0→1); 46 (0→1); 47 (0→1); 57 (1→2); 80 (0→1).	28 (0→1); 39 (0→1); 54 (2→0).	None.
E, Trematosauroidea	11 (0→1); 20 (0→1); 52 (1→2); 58 (1→2); 59 (1→0); 67 (0→1); 69 (0→1); 83 (0→1); 84 (0→1); 85 (0→1); 86 (0→1).	None.	28 (1→0); 34 (1→0); 39 (1→0); 54 (0→2).
Thoosuchus yakovlevi	29 (0→1); 38 (0→2); 72 (0→1).	34 (1→0).	None.
Angusaurus + *Wantzosaurus elongatus*	31 (0→1); 65 (0→1).	34 (1→3);	34 (0→3).
Angusaurus	47 (0→1).	None.	None.
Lyrocephaliscus euri + *Wantzosaurus elongatus*	5 (0→1); 13 (0→1); 40 (0→1); 49 (0→1); 71 (0→2).	None.	9 (1→0).
Lyrocephaliscus euri	2 (1→0); 4 (1→0); 6 (1→0); 19 (0→1); 24 (1→0); 55 (2→1); 64 (0→1).	9 (1→0); 34 (3→0).	34 (3→0).

Trematosaurus brauni + *Wantzosaurus elongatus*	53 (0→1); 70 (0→1).	None.	38 (0→2).
Trematosaurus brauni	54 (2→1); 59 (0→1).	38 (0→2).	9 (0→1).
Platystega depressa + *Wantzosaurus elongatus*	18 (0→1).	None.	77 (1→0).
Platystega depressa	5 (1→0); 8 (1→0); 19 (0→2); 68 (1→0).	34 (3→0).	34 (3→0).
F, slender-headed trematosaurs (*Trematolestes hagdorni* + *Wantzosaurus elongatus*)	47 (0→1).	77 (1→0).	33 (1→0).
G, Lonchorhynchinae	4 (1→2); 5 (1→2); 14 (0→1); 58 (2→1).	None.	84 (1→0).
Aphaneramma rostratum	24 (1→0); 31 (1→0); 37 (1→2).	84 (1→0);	33 (0→1); 38 (2→0); 57 (0→1).
Cosgriffus campi + *Wantzosaurus elongatus*	13 (1→0); 15 (0→1); 59 (0→1).	57 (1→0).	54 (2→0); 70 (1→0).
Cosgriffus campi	6 (1→0); 52 (2→0).	None.	None.
Wantzosaurus elongatus	26 (1→0); 34 (3→1); 51 (0→2); 68 (1→0).	33 (1→0); 38 (0→2); 54 (2→0); 70 (1→0).	None.
Trematolestes hagdorni + *Tertrema acuta*	51 (0→1); 64 (0→2).	9 (1→0); 33 (1→0).	40 (1→0); 81 (1→0).
Tertrema acuta	31 (1→0); 37 (1→0); 47 (1→2); 68 (1→0).	38 (0→2); 51 (1→2).	None.
H, '*Trematolestes* clade' (*Trematolestes hagdorni* + MSNM V2993)	8 (1→0); 10 (0→2); 13 (1→0); 16 (0→1); 26 (1→0).	57 (1→0).	38 (2→0); 73 (0→1).
Trematolestes hagdorni	4 (1→0).	51 (1→2); 73 (0→1); 81 (1→0).	None.
I, *Tertremoides madagascariensis* (*Trematosaurus madagascariensis* + MSNM V2993)	None.	40 (1→0).	19 (0→1); 44 (0→1); 51 (2→1); 53 (1→0); 54 (2→1); 67 (1→0); 69 (1→2).
Trematosaurus madagascariensis	None.	19 (0→1); 44 (0→1).	None.
MSNM V2993 + Malagasy "*Tertrema*" snout	None.	53 (1→0).	None.
Malagasy "*Tertrema*" snout	None.	54 (2→1).	None.
MSNM V2993	None.	67 (1→0); 69 (1→2).	None.

(2006) are consistent with the phylogenetic affinities found in this study and with taxonomic affinities found between MSNM V2993 and the other trematosaurids based on palatal features (as mentioned in the taxonomic affinities section above, MSNM V2993 shows more affinities with *Tertrema acuta* and *Trematolestes hagdorni* than *Trematosaurus brauni*, and has some peculiar features indicating that it belongs to another taxon). This is consistent also with the tentative attribution of MSNM V2993 to cf. *Tertremoides madagascariensis* we proposed above based on skull roof features and skull outline.

Therefore, we cautiously prefer to do not erect a new taxon for MSNM V2993, and - as already mentioned - we provisionally refer it, the snout described by Lehman (1979: figs. 1, 2; pl. IA, B) and the other Malagasy specimens - except from those belonging to *Wantosaurus elongatus* and the indeterminate trematosaurian palate figured by Lehman (1961, pl. III E) - to cf. *Tertremoides madagascariensis* (Lehman, 1966) Schoch & Milner, 2000, pending new, more complete material and a systematic revision of the material so far described. In the end, based on this systematic assignment, we also provide a tentative reconstruction of the palate of cf. *Tertremoides madagascariensis* (Fig. 6).

Size and ontogenetic stage - Interestingly, all the Malagasy specimens referable to *Tertremoides madagascariensis* are large individuals, up to 300 mm in estimated skull length (e.g., Fig. 6), and at the same time they are characterized by large orbits. Skull length is comparable to that of *Tertrema acuta* (Wiman, 1917), and surpasses by far that of adult individuals of *Trematosaurus brauni* (Schoch & Milner, 2000). The orbits of all the Malagasy specimens, MSNM V2993 included, are comparatively larger than those of *Tertrema acuta*, and even more than those of *Trematosaurus brauni*, whereas they are comparable in size to those of the adult skull of *Trematolestes hagdorni*; orbits as large as - or even larger - are retained also in adults of *Wantzosaurus elongatus* (Steyer, 2002). Although absolute size taken alone is not a valid criterion to establish the growth stage (Steyer, 2000), those examples demonstrate that large orbits and adult size can coexist in some species of trematosaurids. Thus, MSNM V2993 and the other specimens of *Tertremoides madagascariensis* could represent either large juvenile individuals of very large trematosaurid species, or adult individuals characterized by retention of comparatively large orbits with reduced interorbital distance. Following Schoch (2006), we consider more plausible the second hypothesis.

Palaeobiology - The dentition of MSNM V2993 indicates a carnivorous diet. The small maxillary teeth and the enlarged palatal teeth formed two parallel rows, with the dentary tooth row fitting between the two upper ones, when the jaws closed. The pointed teeth, circular to oval in cross section, functioned as piercers and graspers rather than slashers and slicers or crushing surfaces. Trematosaurids are commonly regarded as piscivorous and aquatic, some of them clearly marine (e.g., Warren, 2000; Steyer, 2002). Assuming an aquatic mode of life for MSNM V2993, the dental apparatus, the interlocking jaw mechanism, the relatively narrow snout limiting drag in water, and the comparatively large body size would have made it one of the top predators of its ecosystem, well suitable to hold on rapid, slippery preys such as the coeval osteichthyan fishes (e.g., Beltan, 1996) and the soft-bodied invertebrates.
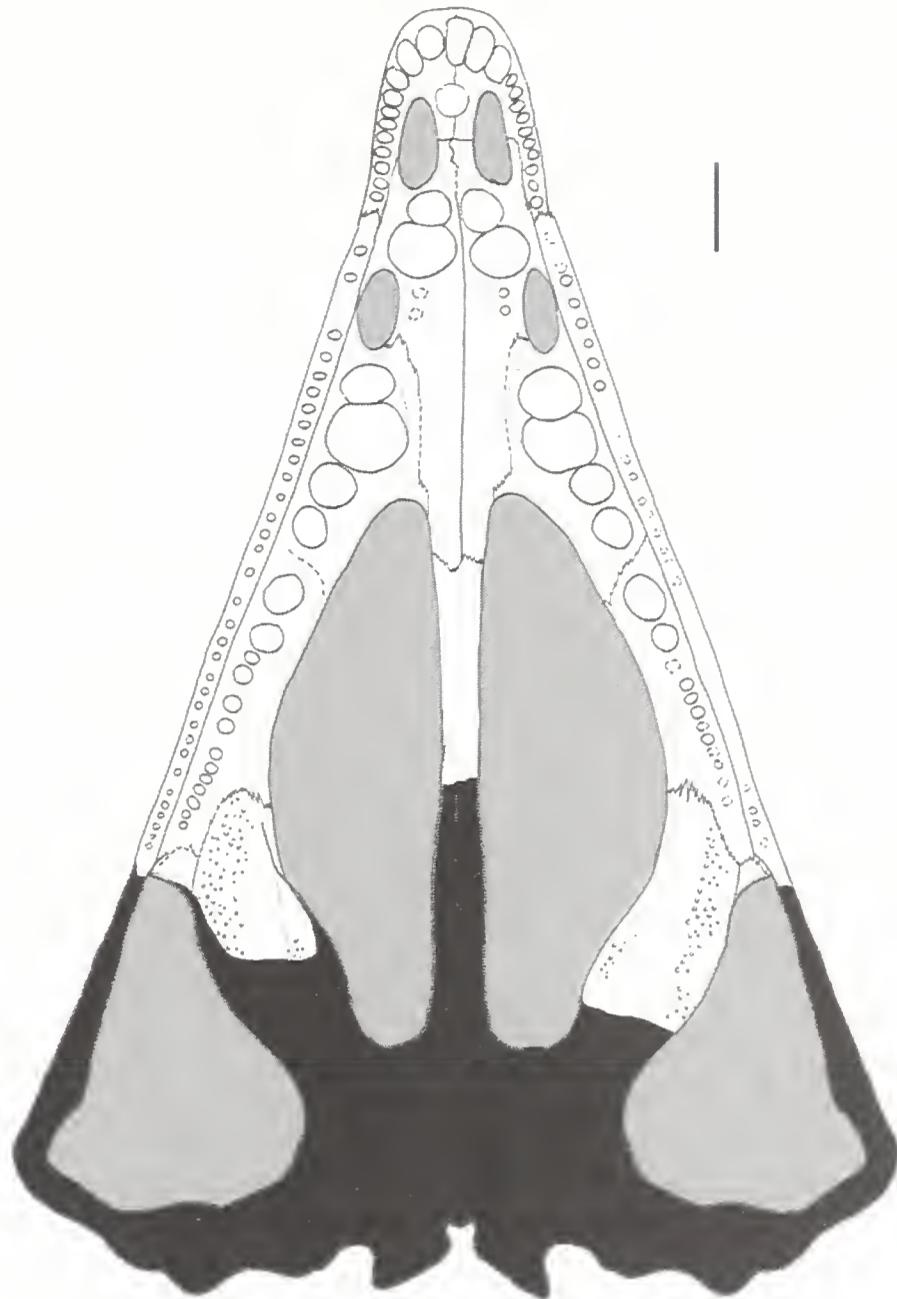
Fig. 6 - Tentative reconstruction of the skull of cf. *Tertremoides madagascariensis* in palatal view, starting from the specimen MSNM V2993. The tip of the snout is from the Malagasy specimen referred to '*Tertrema*' by Lehman (1979). Unknown portions of the palate (in black) have been taken from *Trematolestes hagdorni* and adapted to the skull outline of cf. *Tertremoides madagacariensis*. Scale bar equals 20 mm. (Drawings by SM).

Fig. 6 - Ricostruzione tentativa del cranio di cf. *Tertremoides madagascariensis* in norma palatale, a partire dall'esemplare MSNM V2993. La porzione rostrale del muso è presa dall'esemplare malgascio riferito a '*Tertrema*' da Lehman (1979). Le parti del palato sconosciute (in nero) sono state prese da *Trematolestes hagdorni* e adattate alla forma del cranio di cf. *Tertremoides madagascariensis*. La scala metrica equivale a 20 mm. (Disegni di SM).

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Appendix 1

Sources of data of the terminal taxa added in the present study.

Taxon	Sources
Aphaneramma rostratum	Säve-Söderbergh (1935); Warren (2000).
Cosgriffius campi	Welles (1993).
Lyrocephaliscus euri	Säve-Söderbergh (1936); Schoch & Milner (2000).
Platystega depressa	Säve-Söderbergh (1936).
Tertrema acuta	Wiman (1917).
Malagasy "*Tertrema*" snout	Lehman (1979).
Trematosaurus madagascariensis	Lehman (1966, 1979); Janvier (1992).
Tertremoides ambilobensis	Lehman (1979).

Appendix 2

Codings of the terminal taxa added in the present study, based on character descriptions in Maganuco *et al.* (in press).

Taxa / Characters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Aphaneramma rostratum	0	1	1	2	2	1	?	1	0 1	0	1	0	1	1	0	0	0	1
Cosgriffius campi	0	1	1	2	2	0	0	1	0 1	0	1	0	0	1	1	0	0	1
Lyrocephaliscus euri	0	0	1	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0
Platystega depressa	0	1	1	1	0	1	0	0	0 1	0	1	0	1	0	0	0	0	1
Tertrema acuta	0	1	1	1	1	1	?	1	0	0	1	0	1	0	0	0	0	1
MSNM V2993	?	?	?	?	?	?	?	?	?	2	1	0	0	0	?	?	?	?
Malagasy "*Tertrema*" snout	0	?	?	1	?	1	?	0	0	?	?	?	?	0	?	?	?	?
Trematosaurus madagascariensis	0	1	1	1	1	1	0	0	0	2	1	0	0	0	0	1	0	1
Tertremoides ambilobensis	0	1	1	1	1	1	0	0	0	2	1	0	0	0	0	?	0	?

Taxa / Characters	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Aphaneramma rostratum	0	1	1	0	1	0	1	1	0	0	0	1	0	0	1	3	0	1
Cosgriffius campi	0	1	1	?	1	1	?	1	?	?	?	?	?	?	?	3	?	?
Lyrocephaliscus euri	1	1	1	0	1	0	1	1	0	0	0	1	1	0	1	0	0	1
Platystega depressa	2	1	1	0	?	?	?	?	0	?	?	1	?	?	1	0	?	?
Tertrema acuta	0	1	1	0	1	1	?	1	0	0	0	?	0	?	0	3	0	1
MSNM V2993	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Malagasy "*Tertrema*" snout	?	?	?	?	?	1	?	0 1	?	?	?	?	?	?	?	?	?	?
Trematosaurus madagascariensis	1	1	1	0	1	1 2	1	0	0	0	0	1	1	0	0	3	0	1
Tertremoides ambilobensis	?	1	1	0	1	1	1	0	0	0	0	1	1	0	0	?	?	?

Taxa / Characters	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Aphaneramma rostratum	2	0	0	1	?	0	0	0	1	?	1	1	1	-	0	2	?	2
Cosgriffius campi	?	?	?	?	?	?	?	?	?	0	1	1	1	-	0	0	-	-
Lyrocephaliscus euri	1	0	0	1	?	0	0	?	1	?	0	1	1	-	0	2	0	2
Platystega depressa	?	?	0	?	?	?	?	?	?	?	0	1	1	-	0	2	1	2
Tertrema acuta	0	2	0	?	?	0	0	?	1	?	2	1	1	-	2	2	1	2
MSNM V2993	?	?	?	?	?	?	?	?	?	?	0 1	1	1	-	1	2	0	1 2
Malagasy "*Tertrema*" snout	?	?	?	?	?	?	?	?	?	?	?	1	1	-	?	2	0	1
Trematosaurus madagascariensis	1	0	0	0	?	0	0	1	?	?	?	?	?	?	?	?	?	?
Tertremoides ambilobensis	?	?	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?

Taxa / Characters	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
Aphaneramma rostratum	2	0	1	1	0	0	0	1	0	0	1	0	1	1	1	1	2	0
Cosgriffius campi	2	0	0	1	1	0	?	?	?	?	?	?	1	1	1	?	?	?
Lyrocephaliscus euri	1	0	1	2	0	0	0	1	0	1	1	0	1	1	1	0	2	0
Platystega depressa	2	0	1	2	0	0	0	1	0	?	1	0	1	0	1	1	2	0
Tertrema acuta	2	0	?	2	0	0	0	1	?	2	1	0	1	0	1	1	2	0
MSNM V2993	2	0	0	2	0	0	0	1	?	?	?	?	0	1	2	?	?	?
Malagasy "*Tertrema*" snout	2	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Trematosaurus madagascariensis	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?
Tertremoides ambilobensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

Taxa / Characters	73	74	75	76	77	78	79	80	81	82	83	84	85	86
Aphaneramma rostratum	0	0	0	?	0	1	?	?	1	0	1	0	1	?
Cosgriffius campi	?	?	0	?	?	?	?	?	?	?	?	?	?	?
Lyrocephaliscus euri	0	0	0	?	?	?	?	?	?	?	?	?	?	?
Platystega depressa	0	0	0	?	?	?	?	?	?	?	?	?	?	?
Tertrema acuta	0	?	0	?	?	?	?	?	?	?	?	?	?	?
MSNM V2993	?	0	0 1	?	?	?	?	?	?	?	?	?	?	?
Malagasy "*Tertrema*" snout	?	?	0 1	?	?	?	?	?	?	?	?	?	?	?
Trematosaurus madagascariensis	?	?	?	?	?	?	?	?	?	?	?	?	1	?
Tertremoides ambilobensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?

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Molecular phylogeny of *Polygonum* L. s.l. (Polygonoideae, Polygonaceae), focusing on European taxa: preliminary results and systematic considerations based on *rbc*L plastidial sequence data

Abstract - The Polygonaceae (40-50 genera and approximately 1,100 species) are characterized by the presence of an ocrea, an hyaline or membranous tubular sheath, derived from the fusion of the stipules. Their classification is based principally on macromorphological characters. The broad *Polygonum* s.l. is a much debated genus which has been variously interpreted in the literature: its relation to associated genera is not clear and moreover, it has been subdivided into numerous more natural taxa considered at the rank of genus, subgenus or section.

In the present study, using analysis of the *rbc*L sequence the monophyly of the various taxa that *Polygonum* s.l. has been subdivided are investigated by focusing on the species present in Europe in order to reach a classification more in line with the molecular data.

The phylogenetic tree obtained with the maximum parsimony method confirms that Polygonaceae is monophyletic, however, the subfamily Polygonoideae seems to be paraphyletic as it includes the Eriogonoideae. On the basis of the principal clades identified the restriction of the Polygonoideae to only those taxa with an herbaceous habit is confirmed and a new classification articulated in 4 tribes is proposed: 1) Polygoneae, subdivided into Polygoninae (*Atraphaxis*, *Polygonum* -incl. *Polygonella*- and, probably, *Calligonum*, *Oxygonum*, *Parapteropyrum* and *Pteropyrum*) and Reynoutriinae (*Fallopia*, *Homalocladium*, *Muehlenbeckia*, ×*Reyllopia*, *Reynoutria*) as well as an *incertae sedis* genus (*Knorringia*); 2) Persicarieae, subdivided into Persicariinae **subtrib. nov.** (*Persicaria*) and Koenigiinae (*Aconogonum*, *Bistorta*, *Koenigia*, *Rubrivena*); 3) Fagopyreae (*Fagopyrum*, *Harpagocarpus* and, probably, *Eskemukerjea* and *Pteroxygonum*); 4) Rumiceae (*Emex*, *Oxyria*, *Rheum*, *Rumex*).

Lastly new combinations and/or new names are proposed in the genus ×*Reyllopia*, *Persicaria* and *Rubrivena*.

Key words: Polygonaceae, *Polygonum* s.l., phylogenesis, *rbc*L, classification.

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Riassunto - Filogenesi molecolare di *Polygonum* L. s.l. (Polygonoideae, Polygonaceae), con particolare riferimento alle entità europee: risultati preliminari e considerazioni sistematiche basate sulle sequenze plastidiali *rbc*L.

Le Polygonaceae (40-50 generi e circa 1.100 specie) sono caratterizzate dalla presenza dell'ocrea, una guaina tubolare, membranacea o ialina, derivata dalla fusione delle stipole. La loro classificazione è basata principalmente su caratteri macromorfologici. Un genere molto dibattuto e variamente circoscritto dagli autori è l'ampio *Polygonum* s.l.: i suoi limiti verso i generi vicini non sono molto chiari ed inoltre è stato suddiviso in numerose entità più naturali, variamente considerate a rango di genere, sottogenere o sezione.

In questo lavoro, attraverso l'analisi delle sequenze *rbc*L è stato indagato il monofiletismo dei vari taxa nei quali è suddiviso *Polygonum* s.l., ponendo maggiore attenzione alle specie presenti in Europa, al fine di giungere ad una classificazione maggiormente aderente ai dati molecolari.

L'albero filogenetico ottenuto con il metodo della massima parsimonia conferma il monofiletismo delle Polygonaceae, ma la sottofamiglia delle Polygonoideae appare parafiletica poiché le Eriogonoideae sono annidate al suo interno. In base ai principali cladi individuati, viene confermato il restringimento delle Polygonoideae ai soli taxa ad habitus erbaceo e viene proposta una sua nuova classificazione, articolandola in 4 tribù: 1) Polygoneae, suddivise in Polygoninae (*Atraphaxis*, *Polygonum* -incl. *Polygonella*- e, probabilmente, *Calligonum*, *Oxygonum*, *Parapteropyrum* e *Pteropyrum*) e Reynoutriinae (*Fallopia*, *Homalocladium*, *Muehlenbeckia*, ×*Reyllopia*, *Reynoutria*) più un genere *incertae sedis* (*Knorringia*); 2) Persicarieae, suddivise in Persicariinae **subtrib. nov.** (*Persicaria*) e Koenigiinae (*Aconogonum*, *Bistorta*, *Koenigia*, *Rubrivena*); 3) Fagopyreae (*Fagopyrum*, *Harpagocarpus* e, probabilmente, *Eskemukerjea* e *Pteroxygonum*); 4) Rumiceae (*Emex*, *Oxyria*, *Rheum*, *Rumex*).

Infine vengono proposte nuove combinazioni e/o nuovi nomi nei generi ×*Reyllopia*, *Persicaria* e *Rubrivena*.

Parole chiave: Polygonaceae, *Polygonum* s.l., filogenesi, *rbc*L, classificazione.

Introduction

The Polygonaceae include approximately 40 to 50 genera and approximately 1,100 species (Dammer, 1892, 1893; Cronquist, 1981; Brandbyge, 1993; Stevens, 2001). They are either annual herbs (eg. *Koenigia islandica* of the Artic regions), perennial herbs, shrubs, trees (eg. *Triplaris americana* of the equatorial rain forests) or lianas. The leaves develop from the often swollen nodes and are alternate, seldom opposite or whorled, simple, petiolate to sessile, with generally entire margins. The stipules are nearly always well developed and connate within a tubular sheath which may be either persistent or deciduous, hyaline to membranous, bilobed or fringed at the apex and is referred to as the ocrea. The presence of the ocrea is exclusive to the Polygonaceae, and is the most distinguishing morphological characteristic, even if at times it is reduced in size or absent in the subfamily Eriogonoideae. Extrafloral nectary pits are present at the base of the petioles and in the nodal area of the genera *Fallopia* s.l. (incl. *Reynoutria*) and *Muehlenbeckia* s.l. (incl. *Homalocladium*). The axillary or terminal inflorescence is composed of simple or branched thyrsi panicle-, raceme- or spike-like in appearance which, however, are formed of dichasia or helicoid cymes. The partial inflorescences are subtended by bracts while each flower or group of flowers is subtended by a persistent membranous ocreola which corresponds to the fusion of the bracteoles. The flowers are small, trimerous, hermaphrodite or unisexual, and in the latter case being mostly dioecious. Tepals 2-6, prevalently persistent and often accrescent in fruit, fused at the base in a ± developed hypanthium, forming two whorls of 3 elements or one whorl of 5 elements; in the latter case a tepal is derived from the fusion of

a segment of the outer whorl with one from the inner whorl, determining the characteristic quincuncial aestivation. Stamens being equal, double or triple the number of tepals, ranging from 2 to 9, rarely more, free or basally connate, alternating with the tepals. Tricolporate to pantoporate pollen. Nectaries often present, located between the bases of the filaments or fused into an annular disc at the base of the ovary. Superior ovary, 2-4-carpellate (generally 3-carpellate), unilocular; styles 1-3, free or proximally connate; filiform, peltate or capitate stigmas, entire or variously fringed; unique ovule. Fruit an achene, trigonous or lenticular, mainly subtended by the often accrescent perianth; in more specific terms a diclesium (Spjut, 1994). *Fagopyrum* (buckwheat) and *Coccoloba* (sea grape) produce edible fruit; the petioles of *Rheum* (rhubarb) are edible, as are the leaves of some species of *Rumex* (sorrel). The rhizomes of *Rheum* are also renowned for their medicinal properties. Some genera include ornamental species and common weeds.

The classification of the Polygonaceae has to date been mainly defined on macromorphological characters (presence or absence of an ocrea, woodenness, tepal arrangement) and has been widely debated, so much so that numerous taxonomic schemes have been proposed (see Ronse Decraene & Akeroyd, 1988); two subfamilies Polygonoideae and Eriogonoideae are presently accepted almost universally, based on the presence or absence of the ocrea.

Polygonum s.l. is a widely debated genus which has been interpreted differently by various authors. Its relationships with related genera, such as *Atraphaxis*, *Koenigia*, *Muehlenbeckia* and *Polygonella*, are not very clear; moreover, it has been subdivided into numerous more natural taxa, considered variously at the rank of genus, subgenus or section (see Meisner, 1826, 1856, 1857; Bentham & Hooker, 1880; Dammer, 1892; Gross, 1913a, 1913b; Jaretzky, 1925; Hedberg, 1946; Roberty & Vautier, 1964; Graham & Wood, 1965; Holub, 1971; Soják, 1974; Haraldson, 1978; Tzvelev, 1987; Ronse Decraene & Akeroyd, 1988; Hassan, 1991, 1997; Hassan & Khan, 1992; Hong *et al.*, 1998; Ronse Decraene *et al.*, 2000). The recent biomolecular studies by Cuénoud *et al.* (2002), even if they were on only a few species, and above all those by Lamb Frye & Kron (2003), Kim *et al.* (2005), Kim & Donoghue (2008) and Sanchez & Kron (2008) have revealed that *Polygonum* s.l. is polyphyletic, and should be divided into several genera. The phylogenetic-molecular studies available include only a few species and scarse representation of the types of the genera segregated from *Polygonum*; consequently it is still not clear to what lengths this subdivision may be taken and what are their phylogenetic relationships. The systematic scheme mostly accepted in the literature (Tab. 1) includes the identification of at least 7 genera (some of which are articulated in sections) assigned, together with other genera, to two tribes: the Persicarieae and the Polygoneae. Lamb Frye & Kron (2003), Kim *et al.* (2005) and Sanchez & Kron (2008) have demonstrated that also the genus *Muehlenbeckia*, usually placed within the *Coccolobeae*, is related to *Polygonum* s.l.; this is also often united with the monotypic genus *Homalocladium*, characterised by flattened stems. *Knorringia*, segregated from *Polygonum* s.l. (or from *Aconogonum*) and placed in the *Coccolobeae* (Hong, 1989), may also belong to the *Polygoneae*.

Tab. 1 - Accepted classification of *Polygonum* s.l. species.
Tab. 1 - Classificazione accettata delle specie appartenenti a *Polygonum* s.l.

Persicarieae	Tepals with three main nervatures which depart from the base (with some exceptions in *Fagopyrum*); epidermic cells rectangular to elongate with straight or undulating anticlinal walls, cuticles smooth or striate in longitudinal direction and often continuous.		
	Aconogonum	Inflorescences paniculate, ocreas oblique.	
	Bistorta	Inflorescences spicate, only terminal, rhizome robust and presence of basal leaves, ocreas oblique.	
	Fagopyrum s.l. (= incl. *Eskemukerjea*) (= incl. *Harpagocarpus*) (= incl. *Pteroxygonum*)	Tepals almost free, filaments winged. Asian genus from which the genera *Eskemukerjea* from Nepal, *Harpagocarpus* from eastern Africa and *Pteroxygonum* from China are often segregated, even if, according to Ohsako *et al.* (2001), *Eskemukerjea* would have an isolated position. Furthermore, the position of *Fagopyrum* s.l. within the Polygonoideae is still not clear (see Marek, 1958; Hong *et al.*, 1998; Ronse Decraene *et al.*, 2000) and its collocation within the Persicaarieae is controversial and not accepted by many authors.	
	Koenigia	Inflorescences cymose, pollen spinulose. Some species of *Polygonum* (those of sect. *Eleutherospermum* Hook.f.) have been moved to this genus on the basis of the pollen morphology (Měsíček & Soják, 1973; Hedberg, 1997), as it was at first considered monotypic.	
	Persicaria	Inflorescences spicate or capitate (rarely paniculate in sect. *Rubrivena*). The following 5 sections are generally accepted (sometimes treated as autonomous genera), even if others have been described.	
		sect. ***Persicaria*** (incl. sect. *Amblygonon*)	Inflorescences spicate, ocreas truncate.
		sect. ***Tovara*** (= genus *Antenoron*)	Inflorescences spicate, tepals 4, styles 2, hooked and hardened at maturity.
		sect. ***Cephalophilon*** (= genus *Ampelygonum*)	Inflorescences capitate, ocreas truncate.
		sect. ***Echinocaulon*** (= genus *Truellum*)	Inflorescences capitate, stem angles and leaves with recurved prickles, ocreas oblique.
		sect. ***Rubrivena*** (= genus *Rubrivena*)	Inflorescences paniculate, ocreas oblique. Shows morphological affinities with *Aconogonum* and its species are often attributed to the latter genus.

<table>
<tr><td>Polygoneae</td><td colspan="3">Tepals with one principal nervature, more or less branched; epidermic cells irregular to elongate, rarely rectangular with mostly sinuate anticlinal walls, cuticles rarely with longitudinal striation but with strong orthogonal to reticulate ridges or striae, often without correlation between cells.</td></tr>
<tr><td></td><td>Fallopia s.l.</td><td colspan="2">Outer tepals expanded in fruit or carinate or winged. The following 4 sections are generally accepted.</td></tr>
<tr><td></td><td></td><td>sect. Reynoutria
(= genus Reynoutria)</td><td>Stems erect, flowers functionally unisexual, stigmas fimbriate. Sometimes classed at genus rank.</td></tr>
<tr><td></td><td></td><td>sect. Fallopia
and
sect. Paragonum</td><td>Stems scandent, flowers hermaphrodite, stigmas capitate, inflorescences racemose; they are distinguished on the basis of the trichome features.</td></tr>
<tr><td></td><td></td><td>sect. Pleuropterus
(= sect. Sarmentosae)</td><td>Stems scandent, flowers hermaphrodite, stigmas peltate, inflorescences paniculate.</td></tr>
<tr><td></td><td>Polygonum</td><td colspan="2">Outer tepals not expanded in fruit and not carinate or winged. The recent morphological revision by Ronse Decraene et al. (2004) includes Polygonella in Polygonum and recognizes the following 3 sections.</td></tr>
<tr><td></td><td></td><td>sect. Polygonum</td><td>Pollen Avicularia-type (Hedberg,1946), achenes not winged.</td></tr>
<tr><td></td><td></td><td>sect. Pseudomollia</td><td>Pollen dimorphic (Ronse De Craene et al., 2004), achenes winged along the beak.</td></tr>
<tr><td></td><td></td><td>sect. Duravia
(incl. genus Polygonella)</td><td>Pollen Duravia-type (Hedberg, 1946), achenes not winged.</td></tr>
<tr><td colspan="4">The phylogenetic molecular analyses by Lamb Frye & Kron (2003), Kim et al. (2005) and Sanchez & Kron (2008) show that also the genus Muehlenbeckia, usually placed within the Coccolobeae, has affinities with Polygonum s.l.; the monotypic genus Homalocladium , characterized by flattened stems, is often united with this genus.</td></tr>
<tr><td colspan="4">Also the genus Knorringia, segregated from Polygonum s.l. (or from Aconogonum) and placed within the Coccolobeae (Hong, 1989), may belong to the Polygoneae.</td></tr>
</table>

The third tribe of Polygonoideae with an herbaceous habit is the Rumiceae (genera *Emex*, *Oxyria*, *Rheum* and *Rumex*), retained as being homogenous from a morphological viewpoint. The latter is not taken into consideration here, if only as an outgroup, however it may be the focus of later research. The main aim of this study is to verify the monophyly of the various taxa into which *Polygonum* s.l. (Tab. 1) has been subdivided and therefore the validity of the whole systematic model by mainly focusing on native and alien species present in Europe in order to obtain a classification more in line with the evolutionary history of the group.

Materials and methods

Sampling of taxa - In sampling for the phylogenetic analyses it was attempted to cover the majority of the natural groups belonging or correlated to the complex of *Polygonum* s.l. (tribes Persicarieae and Polygoneae), where possible also including the types of the genera. In particular, the species of the genera *Aconogonum*, *Atraphaxis*, *Bistorta*, *Eskemukerjea*, *Fagopyrum* s.s., *Fallopia* s.l. (3 sections out of 4), *Homalocladium*, *Koenigia*, *Muehlenbeckia* s.s., *Persicaria* (all 5 sections) and *Polygonum* s.s. (incl. *Polygonella*; 2 sections out of 3) have been utilized. Regarding the genus *Fallopia* it was not possible to find the type species (*F. scandens*), however, a closely related species was used (*F. dumetorum*); similarly the species of the sect. *Paragonum* was not found. In relation to *Fagopyrum* and its satellite genera the species and the types of *Fagopyrum* s.s. and *Eskemukerjea* have been recovered from the genetic data banks while the material of *Harpagocarpus* and *Pteroxygonum* is missing. The types of all the *Persicaria* sections have been included; from the sect. *Echinocaulon* also *P. bungeana* has been included, the systematic position of which is still controversial. Finally, for *Polygonum* the sect. *Pseudomollia* has not been included and for the sect. *Duravia* the type was not found. Concerning the genera related to *Polygonum* s.l. the material of *Calligonum*, *Knorringia*, *Oxygonum*, *Parapteropyrum* and *Pteropyrum* has not been found. Some taxa have been included from the Rumiceae (all the genera: *Emex*, *Oxyria*, *Rheum*, *Rumex*), Coccolobeae (*Antigonon*, *Brunnichia*, *Coccoloba*) and Triplareae (*Triplaris*) tribes and from the subfamily Eriogonoideae (*Eriogonum*), in order to clarify the relationships between the genera belonging to *Polygonum* s.l. and the other genera of Polygonaceae.

The outgroups have been selected from the Plumbaginaceae (*Armeria bottendorfensis* and *Plumbago auriculata*), the sister family of the Polygonaceae (Cuénoud *et al.*, 2002).

In Tab. 2 are listed the 96 sequences related to the 92 taxa included in the phylogenetic analyses of the *rbc*L data, with information on the samples utilized and the access number of the relative sequence in the EMBL/GenBank. 41 of the latter have been sequenced for the first time while the remaining 55 have already been published by Fay *et al.* (1997), Forest *et al.* (2007), Kim & Donoghue (2008), Lamb Frye & Kron (2003), Lledó *et al.* (1998), Ohsako *et al.* (2001), Silvertown *et al.* (2006) and Yasui & Ohnishi (1996, 1998b). The species utilized cover almost all the variability of *Polygonum* s.l. within Europe: except for *Polygonum* s.s. which is poorly represented in our samples (2 species out of circa 23), however, these species are very similar, the other genera are present in abundance and only 6 species are missing from among the spontaneous or naturalized species in Europe.

DNA isolation - Total DNAs were isolated from 50-100 mg of fresh, or 20-50 mg of silica-dried or herbarium leaves of individual plants using a commercial kit (DNeasy Plant Mini Kit; QIAGEN). For PCR, DNA samples were adjusted to a concentration of 2 ng/µl in 10 mM Tris, 1 mM EDTA, pH 8.0.

***rbc*L amplification** - Approximately 1.4 kb of the *rbc*L gene was amplified using primers *rbc*L-up (5'-GGACATTACTTGAATGCTACTG-3') and *rbc*L-down (5'-GCATGTACCTGCAGTAGCATT-3') by polymerase chain reaction (PCR, 30 cycles, 1-min denaturation at 94 °C, 30-s annealing at 51 °C, 1-min extension at 72 °C, 7-min final extension). For the amplification of *Persicaria* spp., primer *rbc*L-up was replaced with 1FS (5'-ATCTCACCACAAACAGAAAC-3'), as described by Lamb Frye & Kron (2003).

Tab. 2 - Taxa used in the phylogenetic analysis; the species present in Europe are shown in bold. / Elenco dei taxa utilizzati nell'analisi filogenetica; in grassetto le specie presenti in Europa.

Taxon	Section	Voucher/Source	Locality	Gene-Bank n
Aconogonum alpinum (All.) Schur		MSNM 32.861	Italy; Piemonte; VB; Formazza	FM883602
Aconogonum angustifolium (Pall.) H.Hara		Lamb Frye & Kron (2003)		AF297139
Aconogonum divaricatum (L.) Nakai		Only fresh material	Sweden	FM883603
Aconogonum ×fennicum Reiersen (= *A. alpinum* × *weyrichii*)		Only fresh material	Sweden	FM883604
Aconogonum molle (D.Don) H.Hara (= *A. paniculatum* (Blume) Haraldson)[1]		Lamb Frye & Kron (2003)		AF297129
Aconogonum weyrichii (F.Schmidt) H.Hara		Lamb Frye & Kron (2003)		AF297145
Antigonon leptopus Hook. & Arn.		Lamb Frye & Kron (2003)		AF297146
Atraphaxis spinosa L.		Lamb Frye & Kron (2003)		AF297123
Bistorta affinis (D.Don) Greene		Only fresh material	Italy; Lombardia; MI; Milano; MSNM Botanic Garden	FM883605
Bistorta amplexicaulis (D.Don) Greene		Only fresh material	Italy; Lombardia; MI; Milano; MSNM Botanic Garden	FM883606
Bistorta officinalis Delarbre (≡ *Polygonum bistorta* L.)		MSNM 24.720	Italy; Lombardia; BS; Breno	FM883607
Bistorta vivipara (L.) Delarbre		MSNM 24.721	Italy; Lombardia; BS; Breno	FM883608
Brunnichia ovata (Walter) Shinners (= *B. cirrhosa* Gaertn.)		Lamb Frye & Kron (2003)		AF297136
Coccoloba densifrons Mart.		Lamb Frye & Kron (2003)		AF297138
Coccoloba swartzii Meisn.		Lamb Frye & Kron (2003)		AF297150
Emex spinosa (L.) Campd.		Lamb Frye & Kron (2003)		AF297142
Eriogonum flavum Nutt.		Fay *et al.* (1997)		Z97648
Eriogonum tomentosum Michx.		Lamb Frye & Kron (2003)		AF297134
Eskemukerjea megacarpa (H.Hara) H.Hara (= *E. nepalensis* Malick & Sengupta)		Ohsako *et al.* (2001)		AB056690
Fagopyrum callianthum Ohnishi		Yasui & Ohnishi (1998b)		AB000302

[1] The sequenced taxon corresponds to var. *frondosum* (Meisn.) H.Hara (= *A. paniculatum*). / L'entità sequenziata corrisponde alla var. *frondosum* (Meisn.) H.Hara (= *A. paniculatum*).

Taxon	Section	Voucher/Source	Locality	Gene-Bank n
Fagopyrum capillatum Ohnishi		Yasui & Ohnishi (1998b)		AB000303
Fagopyrum dibotrys (D.Don) H.Hara (= *F. cymosum* (Trev.) Meisn.)		Yasui & Ohnishi (1998b)		AB000304
Fagopyrum esculentum Moench subsp. ***esculentum***		Yasui & Ohnishi (1998b)		AB000309
Fagopyrum gilesii (Hemsl.) Hedberg		Ohsako *et al.* (2001)		AB056689
Fagopyrum gracilipes (Hemsl.) Dammer ex Diels		Yasui & Ohnishi (1998b)		AB000311
Fagopyrum homotropicum Ohnishi		Yasui & Ohnishi (1998b)		AB000312
Fagopyrum leptopodum (Diels) Hedberg var. *leptopodum*		Yasui & Ohnishi (1998b)		AB000313
Fagopyrum lineare (Sam.) Haraldson		Yasui & Ohnishi (1998b)		AB000314
Fagopyrum macrocarpum Ohsako & Ohnishi		Ohsako *et al.* (2001)		AB056687
Fagopyrum pleioramosum Ohnishi		Yasui & Ohnishi (1998b)		AB000315
Fagopyrum rubifolium Ohsako & Ohnishi		Ohsako *et al.* (2001)		AB056686
Fagopyrum statice (H.Lév.) H.Gross		Yasui & Ohnishi (1998b)		AB000317
Fagopyrum tataricum (L.) Gaertn. subsp. *potanini* Batalin		Yasui & Ohnishi (1998b)		AB000318
Fagopyrum tataricum (L.) Gaertn. subsp. ***tataricum***		Yasui & Ohnishi (1998b)		AB000319
Fagopyrum urophyllum (Bureau & Franch.) H.Gross		Yasui & Ohnishi (1998b)		AB000321
Fallopia baldschuanica (Regel) Holub (= *F. aubertii* (L.Henry) Holub)	*Fallopia* sect. *Pleuropterus*	Only fresh material	Italy; Lombardia; LC; Rovagnate	FM883609
Fallopia ×bohemica (Chrtek & Chrtková) J.P.Bailey (= *F .japonica* var. *japonica* ♀ × *sachalinensis* ♂)	*Fallopia* sect. *Reynoutria*	MSNM 40.867	Italy; Lombardia; MI; Milano	FM883610
Fallopia × bohemica (Chrtek & Chrtková) J.P.Bailey (= *F. japonica* var. *japonica* ♀ × *sachalinensis* ♂)	*Fallopia* sect. *Reynoutria*	MSNM 40.967	Italy; Lombardia; VA; Somma Lombardo	FM883611
Fallopia convolvulus (L.) Á.Löve	*Fallopia* sect. *Fallopia*	MSNM 40.162	Italy; Lombardia; MI; Milano	FM883612
Fallopia dumetorum (L.) Holub	*Fallopia* sect. *Fallopia*	MSNM 39.131	Italy; Liguria; SV; Pietra Ligure	FM883613
Fallopia japonica (Houtt.) Ronse Decr. var. ***compacta*** (Hook.f.) J.P.Bailey	*Fallopia* sect. *Reynoutria*	Only fresh material	Italy; Lombardia; MI; Milano; MSNM Botanic Garden	FM883614

Taxon	Section	Voucher/Source	Locality	Gene-Bank n
Fallopia japonica (Houtt.) Ronse Decr. var. ***japonica***	*Fallopia* sect. *Reynoutria*	MSNM 40.965	Italy; Lombardia; MI; Milano	FM883615
Fallopia multiflora (Thunb.) Haraldson	*Fallopia* sect. *Pleuropterus*	MSNM 39.993	Italy; Lombardia; BG; Ponte San Pietro	FM883616
Fallopia sachalinensis (F.Schimdt) Ronse Decr.	*Fallopia* sect. *Reynoutria*	Lamb Frye & Kron (2003)		AF297125
Homalocladium platycladum (F.Muell.) L.H.Bailey		MSNM 34.030	Italy; Liguria; IM; Ventimiglia; Villa Hanbury Botanic Garden	FM883617
Koenigia forrestii (Diels) Mesícek & Soják		Lamb Frye & Kron (2003)		AF297144
Koenigia islandica L.		Kim & Donoghue (2008)		EF653763
Muehlenbeckia australis (G.Forst.) Meisn.		Only fresh material	Australia	FM883618
Muehlenbeckia complexa (A.Cunn.) Meisn.		MSNM 3.296	Italy; Lombardia; MI; Cuggiono	FM883619
Oxyria sinensis Hemsl.		Lamb Frye & Kron (2003)		AF297148
Persicaria acuminata (Kunth) M.Gómez	*Persicaria* sect. *Persicaria*	MSNM 36.839	Brasil; RS; Caxias do Sul	FM883620
Persicaria amphibia (L.) Delarbre	*Persicaria* sect. *Persicaria*	MSNM 39.400	Italy; Lombardia; MI; Milano	FM883621
Persicaria amphibia (L.) Delarbre	*Persicaria* sect. *Persicaria*	Silvertown *et al.* (2006)		AY395553
Persicaria arifolia (L.) Haraldson	*Persicaria* sect. *Echinocaulon*	Kim & Donoghue (2008)		EF653770
Persicaria bungeana (Turcz.) Nakai	*Persicaria* sect. *Echinocaulon*	MSNM 41.053	Italy; Veneto; VI; Grancona	FM883622
Persicaria capitata (Buch.-Ham. ex D.Don) H.Gross	*Persicaria* sect. *Cephalophilon*	Only fresh material	Italy; Liguria; IM; Ventimiglia; Villa Hanbury Botanic Garden	FM883623
Persicaria decipiens (R.Br.) K.L.Wilson (= *P. salicifolia* (Brouss. ex Willd.) Assenov, non Gray)	*Persicaria* sect. *Persicaria*	MSNM 40.945	Italy; Sicilia; SR; Siracusa	FM883624
Persicaria dubia (Stein) Fourr. (= *P. mitis* (Schrank) Assenov)	*Persicaria* sect. *Persicaria*	MSNM 26.625	Italy; Lombardia; MI; Milano	FM883625
Persicaria filiformis (Thunb.) Nakai	*Persicaria* sect. *Tovara*	MSNM 40.839	Italy; Lombardia; CO; Figino Serenza	FM883628
Persicaria filiformis (Thunb.) Nakai 'Painter's Palette'	*Persicaria* sect. *Tovara*	Only fresh material	Italy; Lombardia; MI; Milano; MSNM Botanic Garden	FM883626
Persicaria filiformis (Thunb.) Nakai 'Variegata'	*Persicaria* sect. *Tovara*	Only fresh material	Italy; Lombardia; MI; Milano; MSNM Botanic Garden	FM883627
Persicaria hydropiper (L.) Delarbre	*Persicaria* sect. *Persicaria*	Only fresh material	Italy; Lombardia; MI; Milano	FM883629

Taxon	Section	Voucher/Source	Locality	Gene-Bank n
Persicaria lapathifolia (L.) Delarbre subsp. ***lapathifolia***	*Persicaria* sect. *Persicaria*	MSNM	Italy; Lombardia; MI; Milano	FM883630
Persicaria longiseta (Bruijn) Kitag.	*Persicaria* sect. *Persicaria*	MSNM 40.958	Italy; Lombardia; MB; Lesmo	FM883631
Persicaria meisneriana (Cham. & Schltdl.) M.Gómez	*Persicaria* sect. *Echinocaulon*	Kim & Donoghue (2008)		EF653772
P. microcephala (D.Don) H.Gross 'Red Dragon'	*Persicaria* sect. *Cephalophilon*	MSNM 41.049	Italy; Lombardia; MI; Milano; MSNM Botanic Garden	FM883632
Persicaria minor (Huds.) Opiz	*Persicaria* sect. *Persicaria*	MSNM 41.046	Italy; Lombardia; MI; Trezzo sull'Adda	FM883633
Persicaria nepalensis (Meisn.) H.Gross	*Persicaria* sect. *Cephalophilon*	MSNM 39.369	Italy; Lombardia; VA; Casalzuigno	FM883634
Persicaria odorata (Lour.) Soják	*Persicaria* sect. *Persicaria*	MSNM	Italy; Lombardia; MI; Milano; Cascina Rosa Botanic Garden	FM883635
Persicaria orientalis (L.) Spach	*Persicaria* sect. *Persicaria*	Only fresh material	Italy; Lombardia; VA; Vergiate	FM883636
Persicaria pensylvanica (L.) M.Gómez	*Persicaria* sect. *Persicaria*	MSNM 39.267	Italy; Lombardia; MI; Settimo Milanese	FM883637
Persicaria punctata (Elliott) Small	*Persicaria* sect. *Persicaria*	MSNM 24.827	Brasil; RS; Capão de Canoa	FM883638
Persicaria runcinata (Buch.-Ham. ex D.Don) Meisn.	*Persicaria* sect. *Cephalophilon*	Lamb Frye & Kron (2003)		AF297124
Persicaria sagittata (L.) H.Gross ex Nakai	*Persicaria* sect. *Echinocaulon*	Kim & Donoghue (2008)		EF653773
Persicaria senticosa (Meisn.) Nakai	*Persicaria* sect. *Echinocaulon*	Yasui & Ohnishi (1996)		D86289
Persicaria thunbergii (Siebold & Zucc.) H.Gross (≡ *Polygonum thunbergii* Siebold & Zucc.; = *Persicaria maackiana* (Regel) Nakai ≡ *Polygonum maackianum* Regel)[2]	*Persicaria* sect. *Persicaria*	Kim & Donoghue (2008)		EF653771
Persicaria tinctoria (Aiton) Spach	*Persicaria* sect. *Persicaria*	Only fresh material	Italy; Lombardia; MI; Milano; Cascina Rosa Botanic Garden	FM883639
Persicaria virginiana (L.) Gaertn.	*Persicaria* sect. *Tovara*	MSNM 39.309	Italy; Lombardia; LC; Cernusco Lombardone	FM883641

[2] The sequenced taxon corresponds to *P. maackiana*, which Park (1988) nevertheless reduced to a simple variety of *P. thunbergii*; due to the lack of a specific study and a combination at varietal rank in *Persicaria*, it is preferred to use the binomial used in the present study. / L'entità sequenziata corrisponde a *P. maackiana*, che tuttavia Park (1988) riduce a semplice varietà di *P. thunbergii*; in mancanza di uno studio specifico e di una combinazione a rango varietale in *Persicaria*, preferiamo utilizzare il binomio qui riportato.

Taxon	Section	Voucher/Source	Locality	Gene-Bank n
Persicaria wallichii Greuter & Burdet	*Persicaria* sect. *Rubrivena*	MSNM 39.191	Italy; Piemonte; VB; Premeno	FM883640
Polygonella robusta (Small) G.L.Nesom & V.M.Bates[3]	*Polygonum* sect. *Duravia*	Lamb Frye & Kron (2003)		AF297132
Polygonum aviculare L.	*Polygonum* sect. *Polygonum*	Lamb Frye & Kron (2003)		AF297127
Polygonum erectum L.	*Polygonum* sect. *Polygonum*	Lamb Frye & Kron (2003)		AF297128
Polygonum rurivagum Jord. ex Boreau	*Polygonum* sect. *Polygonum*	MSNM 40.903	Italy; Lombardia; BS; Manerba del Garda	FM883642
Polygonum undulatum (L.) P.J.Bergius	*Polygonum* sect. *Polygonum*	Forest *et al.* (2007)		AM235078
Rheum kialense Franch.				AB232461
Rheum palmatum L.				AB232452
Rheum rhabarbarum L. (= *R. undulatum* L.)				AB232458
Rheum rhaponticum L.				AB232459
Rumex acetosa L.		Silvertown *et al.* (2006)		AY395559
Rumex acetosella L.		Yasui & Ohnishi (1996)		D86290
Rumex induratus Boiss. & Reut.		Lamb Frye & Kron (2003)		AF297122
Rumex obtusifolius L.		Lamb Frye & Kron (2003)		AF297126
Triplaris americana L.		Lledó *et al.* (1998)		Y16910
Triplaris poeppigiana Wedd.		Lamb Frye & Kron (2003)		AF297137
Outgroup				
Armeria bottendorfensis A.Schulz (Plumbaginaceae)		Fay *et al.* (1997)		Z97640
Plumbago auriculata Lam. (Plumbaginaceae)		Lledó *et al.* (1998)		Y16906

The PCR amplification was conducted under the same conditions with the annealing temperature at 48 °C. All PCRs contained 10 µmol/L primers in 25-µL reactions by using Ready-To-Go PCR Beads (Amersham Pharmacia Biotech, Uppsala, Sweden) and following the manufacturer's standard protocol. The amplified product was empirically estimated by sight after electrophoresis of the fragments marked with 1-µL ethidium-bromide in a 1% agarose gel. The PCR products were then purified using QIAquick PCR purification kit (Qiagen). Cycle sequencing (25 cycles, 10-s denaturation at 96 °C, 5-s annealing at 56 °C, 4-min extension at 60 °C) with dye

[3] As far as is known there is no specific binomial available for this species within *Polygonum*, also due to the presence of the earlier homonym *Polygonum robustum* Meisn.; in the present study the combination of the genus *Polygonella* has been retained. / Per questa specie non vi è, per quanto ne sappiamo, un binomio specifico disponibile in *Polygonum*, anche per la presenza dell'omonimo anteriore *Polygonum robustum* Meisn.; in questo lavoro abbiamo pertanto mantenuto la combinazione nel genere *Polygonella*.

terminators (BigDye Terminator v3.1 Cycle Sequencing kit from Applied Biosystems, Warrington, Cheshire, UK) was performed in 10-µL volumes, and the products were then purified by ethanol precipitation. The redissolved samples were run on an Applied Biosystems 3100 Genetic Analyzer automated DNA sequencer following the manufacturer's protocols. Double readings were made and primers for this sequence determination were *rbc*L-up, *rbc*L 2up (5'-GGACATTACTTGAATGCTACTG-3'), *rbc*L-down or 1FS and *rbc*L 2-down 5'-GCATGTACCTGCAGTAGCATT-3').

Data analysis - The boundaries of sequences were determinated by comparison of the newly obtained sequences with those downloaded from the GenBank. Sequences were aligned using the Clustal X 1.8.1 (Thompson *et al.*, 1997) computer program and were refined manually. Phylogenies were reconstructed by using maximum parsimony optimality criterion using MEGA4 (Tamura *et al.*, 2007) and PAUP version 4.0 (Swofford, 2002). The MP tree was obtained using the Close-Neighbor-Interchange algorithm (Nei & Kumar, 2000) with search level 3 in which the initial trees were obtained with the random addition of sequences (200 replicates). Confidence in nodes was assessed using the bootstrap method with 5000 replicates. The tree was rooted using taxa from *Armeria* and *Plumbago*, whose family had previously been shown to be an appropriate outgroup (Cuénoud *et al.*, 2002).

Results

The evolutionary history was inferred using the Maximum Parsimony method. Of 1,334 total characters in the data matrix, 824 (62%) are constant characters, 253 (19%) are variable characters that are parsimony-uninformative, and 257 (19%) are parsimony-informative variable characters. Branches corresponding to partitions reproduced in less than 50% trees are collapsed. Parsimony analysis of the data yielded 976 most parsimonious trees of 1,027 steps with a consistency index (CI) of 0.595, retention index (RI) of 0.808, and rescaled consistency index (RC) of 0.481. The mean composition of nucleotide bases in this alignment was as follows: T = 28.9%, G = 24.1%, C = 20.3%, A = 26.7%. The majority-rule consensus of the phylogenetic trees obtained by MEGA4 and Paup provided the same topology (Fig. 1). Polygonaceae are confirmed to be a monophyletic family (100% bootstrap support), according to the systematic tradition and the previous molecular analysis (Cuénoud *et al.*, 2002; Lamb Frye & Kron, 2003; Kim *et al.*, 2005; Sanchez & Kron, 2008). The tree illustrates the relationships within Polygonaceae and it indicates 2 blocks, not corresponding to the traditional suddivision in Eriogonoideae and Polygonoideae. Block I includes 9 still unresolved major lineages (clades I-IX). *Fallopia* s.l., *Muehlenbeckia* s.l. and *Persicaria* are not monophyletic genera, justifying their splitting. This is in agreement with previous morphological studies and systematic proposals, suggesting that the *rbc*L phylogram reflects the true phylogeny, even if the full picture of the species phylogeny cannot be concluded solely from a single gene.

Fig 1 - Phylogram based on maximum parsimony analysis of the *rbc*L sequences. *Armeria* and *Plumbago* (Plumbaginaceae) were considered as the outgroup. Bootstrap values > 50% are shown on the branches.

Fig 1 - Filogramma basato sull'analisi della massima parsimonia delle sequenze *rbc*L. Come *outgroup* sono utilizzati *Armeria* e *Plumbago* (Plumbaginaceae). Sopra i rami sono mostrati i valori di *bootstrap* > 50%.

Persicaria odorata
Persicaria minor
Persicaria hydropiper
Persicaria dubia
Persicaria tinctoria
Persicaria maculosa
Persicaria longiseta
Persicaria punctata
Persicaria pensylvanica
Persicaria decipiens
Persicaria lapathifolia
Persicaria orientalis
Persicaria acuminata
Persicaria bungeana
Persicaria amphibia (Milano, Italy)
Persicaria amphibia (Gene Bank)
Persicaria senticosa
Persicaria sagittata
Persicaria meisneriana
Persicaria arifolia
Persicaria thunbergii
Persicaria virginiana
Persicaria filiformis
Persicaria filiformis 'Variegata'
Persicaria filiformis 'Painter's Palette'
Persicaria runcinata
Persicaria capitata
Persicaria microcephala 'Red Dragon'
Persicaria nepalensis
Polygonum rurivagum
Polygonum erectum
Polygonum aviculare
Polygonum undulatum
Polygonella robusta
Atraphaxis spinosa
Fallopia japonica var. japonica
Fallopia x bohemica (Somma Lombardo, Italy)
Fallopia x bohemica (Milano, Italy)
Fallopia japonica var. compacta
Fallopia sachalinensis
Fallopia multiflora
Fallopia dumetorum
Fallopia convolvulus
Fallopia baldschuanica
Homalocladium platycladum
Muehlenbeckia complexa
Muehlenbeckia australis
Bistorta vivipara
Bistorta officinalis
Bistorta amplexicaulis
Bistorta affinis
Persicaria wallichii
Koenigia forrestii
Koenigia islandica
Aconogonum angustifolium
Aconogonum divaricatum
Aconogonum alpinum
Aconogonum weyrichii
Aconogonum molle
Aconogonum x fennicum
Eskemukerjea megacarpa
Rumex obtusifolius
Rumex induratus
Rumex acetosa
Rumex acetosella
Emex spinosa
Oxyria sinensis
Rheum undulatum
Rheum rhaponticum
Rheum palmatum
Rheum kialense
Fagopyrum tataricum subsp tataricum
Fagopyrum tataricum subsp potanini
Fagopyrum homotropicum
Fagopyrum esculentum
Fagopyrum dibotrys
Fagopyrum macrocarpum
Fagopyrum callianthum
Fagopyrum urophyllum
Fagopyrum gilesii
Fagopyrum statice
Fagopyrum leptopodum
Fagopyrum gracilipes
Fagopyrum capillatum
Fagopyrum pleioramosum
Fagopyrum lineare
Fagopyrum rubifolium
Brunnichia ovata
Triplaris americana
Triplaris poeppigiana
Coccoloba densifrons
Coccoloba swartzii
Antigonon leptopus
Eriogonum tomentosum
Eriogonum flavum
Armeria bottendorfensis
Plumbago auriculata
Clade I
Clade II a
Clade II b
Clade III
Clade IV
Clade V
Clade VI
Clade VII
Clade VIII
Clade IXa
Clade IXb
Clade X

Discussion and systematic-phylogenetic arrangement of *Polygonum* s.l.

The family Polygonaceae, analogously to what has been demonstrated by Lamb Frye & Kron (2003), Kim *et al.* (2005) and Sanchez & Kron (2008), appears to be monophyletic (bootstrap 100%). However, the subfamily Polygonoideae is paraphyletic as it includes the Eriogonoideae, though with a low bootstrap (57%). In Fig. 1 the Polygonaceae are subdivided into two large blocks: the first (block I: clades I-IX; bootstrap 77%) comprises the present tribes Persicarieae, Polygoneae and Rumiceae, the second (block II: clade X; bootstrap 57%) the Eriogonoideae and the remaining wooden tribes of the Polygonoideae. On the basis of these results Sanchez & Kron (2008) proposed a new outline of the subfamily, restricting the Polygonoideae to the only prevalently herbaceous tribe (block I of our tree) and including the wooden tribes in the Eriogonoideae (block II of our tree); the results presented here confirm these conclusions with which the authors agree.

The Polygonoideae s.s. (block I) is not resolved and has 9 clades which on the basis of the rich morphological evidence, may nevertheless be grouped into almost 4 superclades corresponding to 4 tribes: Polygoneae, Persicarieae, Fagopyreae and Rumiceae. Consequently, a new systematic model is put forward for the species belonging to these tribes. Subsequent analyses comprising a greater number of species or sequences may lead to slight modifications of the model. With regard to the nomenclature of the suprageneric taxa the authors have collaborated with Adriano Soldano (Vercelli), and the latter appears as co-author of the new nomenclatural subtribal name.

Subfamilia **Polygonoideae** Eaton
(block I: clades I-IX, bootstrap 77%)

Block I, composed of clades I-IX corresponds to the subfamily Polygonoideae, thus as redefined by Sanchez & Kron (2008). It is subdivided into four tribes.

Tribus **Polygoneae** Rchb.
(clade II, bootstrap 99%)

Clade II corresponds well to the tribe Polygoneae, as defined by Ronse Decraene & Akeroyd (1988), with the addition of *Muehlenbeckia* and *Homalocladium*. It is characterized by:

1) tepals with a principal nervature, more or less branched,

2) epidermic cells irregular to elongate, rarely rectangular with mostly sinuate anticlinal walls, cuticles rarely with longitudinal striation but with strong orthogonal to reticulate ridges or striae, often without correlation between cells (type II sensu Hong *et al.*, 1998),

3) nectariferous zone generally not well developed externally to form visible nectaries (except, for example, in *Muehlenbeckia*) but being buried in the receptacle or fused with the base of the innner filaments that thus appear thickened proximally; trichomes or papillae absent or range from a few to several.

This clade results as being subdivided into two subclades, assignable to two subtribes: the Polygoninae and the Reynoutriinae.

Subtribus **Polygoninae** Roberty & Vautier
(clade II a, bootstrap 65%)
= *Atraphaxidinae* H.Gross
= *Calligoninae* Roberty & Vautier
Genera included: *Atraphaxis*, *Polygonum* (incl. *Polygonella*) and, probably, *Calligonum*, *Oxygonum*, *Parapteropyrum* and *Pteropyrum*.

Polygonum L. (ca. 75 spp.)
T: *Polygonum aviculare* L., typ. cons.
= *Polygonella* Michx.
T: *Polygonella parvifolia* Michx. (= *Polygonella polygama* (Vent.) Engelm. & A.Gray)

The tepal structure in *Polygonella* is very similar to that of *Polygonum* s.s., especially to that of the sect. *Duravia* (Ronse Decraene & Akeroyd, 1988; Hong *et al.*, 1998). This similarity, supported also by the pollen morphology (Hedberg, 1946; Hong *et al.*, 2005), by the floral morphology (Ronse Decraene & Akeroyd, 1988; Ronse Decraene *et al.*, 2004) and by anatomical evidence (Haraldson, 1978), induced Ronse Decraene *et al.* (2004) to propose the union with *Polygonum* s.s. at the level of subsection. It should be noted, however, that the combinations proposed by Ronse Decraene *et al.* (2004) are not valid, as the basionyms are not cited. The present results are in line with a sister relationship between the sect. *Polygonum* and *Duravia*, however, as they are based on only a few species of this genus they cannot fully confirm the theory of Ronse Decraene *et al.* (2004).

In the case of *Polygonella robusta*, sometimes considered a variety of *P. fimbriata* (Horton, 1963) however, it is quite distinct from the latter (Nesom & Bates, 1984; Freeman, 2005), there is no specific binomial available, as far as is known, in *Polygonum*, also due to the presence of the earlier homonym *Polygonum robustum* Meisn. It would be necessary to find a valid synonym within *Polygonum* or to set up a new name; in the meantime in the present study the combination within the genus *Polygonella* has been retained.

Polygonum L. sect. ***Duravia*** S.Watson (ca. 31 spp.)
T: *Polygonum californicum* S.Watson
= *Polygonella* Michx.
T: *Polygonella parvifolia* Michx. (= *Polygonella polygama* (Vent.) Engelm. & A.Gray)
= *Gonopyrum* Fisch. & C.A.Mey. [1840](“1845”)
≡ *Psammogonum* Nieuwl. [1914]
T: *G. americanum* Fisch. & C.A.Mey. (≡ *Polygonella a.* (Fisch. & C.A.Mey.) Small)
= *Thysanella* A.Gray [1845]
T: *T. fimbriata* (Elliott) A.Gray (≡ *Polygonum f.* Elliott)

Polygonum L. sect. ***Polygonum*** (ca. 45 spp.)
≡ *Avicularia* (Meisn.) Börner
T: *Polygonum aviculare* L., typ. cons.
= *Tephis* Adans.
≡ *Polygonum* L. sect. Tephis (Adans.) Meisn.
T: *Atraphaxis undulata* L. (≡ *Polygonum u.* (L.) P.J.Bergius)

Polygonum L. sect. ***Pseudomollia*** Boiss. (1 sp.)
T: *Polygonum molliaeforme* Boiss.

Atraphaxis L. (ca. 25 spp.)
T: *Atraphaxis spinosa* L.

Calligonum L. (35-80 spp.)
T: *Calligonum polygonoides* L.

Oxygonum Burch. ex Campd. (ca. 30 spp.)
T: *Oxygonum alatum* Burch.

Parapteropyrum A.J.Li (1 sp.)
T: *Parapteropyrum tibeticum* A.J.Li

Pteropyrum Jaub. & Spach (4-5 spp.)
T: *Pteropyrum aucheri* Jaub. & Spach

The genera *Atraphaxis*, *Calligonum* and *Pteropyrum* are among those which have in common a particular type of tepal nervature (Vautier, 1949), which are petaloid and not proximally fused (Ronse Decraene & Akeroyd, 1988); they are also closely associated by anatomical (Perdrigeat, 1900; Haraldson, 1978) and pollen (Hedberg, 1946) characters. The monotypic genus *Parapteropyrum* is closely related to *Pteropyrum* and has a very similar pollen (Hong, 1995); they are distinguished on the basis of a few characters of the floral morphology (Li, 1981). Ronse Decraene & Akeroyd (1988) also associate *Oxygonum* to *Atraphaxis* and *Pteropyrum*. Nevertheless, this is differentiated on the basis of the type III epidermic cells (sensu Hong *et al.*, 1998), analogously to *Fagopyrum* sect. *Fagopyrum* and *Eskemukerjea*: mostly irregular, mammiliform, papillose, with either longitudinal tightly pressed or randomly ridged cuticles.

The position of these genera with respect to the other Polygonoideae is thus still doubtful, though Ronse Decraeene & Akeroyd (1988) relate them to *Polygonum* s.s. Both the present results and those of Lamb Frye & Kron (2003), which includes only one of these genera, clearly place *Atraphaxis* in a sister position with respect to *Polygonum*. Until confirmation is provided by the study of the DNA sequences of the other genera, it seems plausible to the authors to consider them to have morphological affinities with *Atraphaxis* and therefore unite them within the tribe of Polygoninae, even if the pollen characters (Hong, 1995) and the tepal morphology (Hong *et al.*, 1998) place *Oxygonum*, *Parapteropyrum* and *Pteropyrum* closer to the Fagopyrinae.

Subtribus **Reynoutriineae** Roberty & Vautier
(clade II b, bootstrap 71%)
= *Muhlenbeckiinae* Roberty & Vautier
Genera included: *Fallopia*, *Homalocladium*, *Muehlenbeckia*, ×*Reyllopia*, *Reynoutria*.

The Reynoutriineae and the Muehlenbeckiinae were described simultaneously by Roberty & Vautier (1964) and therefore would have equal priority; in the present study priority is given to Reynoutriineae.

Haraldson (1978) was the first to demonstrate the close relationship between the genera *Fallopia* s.l. (incl. *Reynoutria*) and *Muehlenbeckia* s.l. (incl. *Homalocladium*) and he placed them in the tribe Coccolobeae, together with *Antigonon*, *Brunnichia*, *Coccoloba*, *Harpagocarpus* and *Podopterus*. Nevertheless, analogously to the cladograms of Lamb Frye & Kron (2003) and of Sanchez & Kron (2008) and the results of Kim *et al.* (2005), *Coccoloba* and the majority of these genera (excluding *Harpagocarpus*) show no affinity with *Fallopia* and *Muehlenbeckia* and even fall outside of the Polygonoideae. *Harpagocarpus* could show instead affinities with *Fagopyrum* (Ronse Decraene & Akeroyd, 1988), while *Fallopia* s.l. and *Muelenbeckia* s.l. fall without doubt within the Polygoneae. The latter two genera are characterized by the synapomorphy of the presence of extrafloral pit nectaries at the base of the petioles and in the node position which attract some ant species that attack the phytophagous insects (Salisbury, 1909; Sukopp & Schick, 1991; Kawano *et al.*, 1999); they may also be ascribed to their own subtribe. It would also be interesting to be able to also verify the similarity of the pollen morphology.

The genus *Fallopia* s.l. is paraphyletic as *Muehlenbeckia* is nested within it. A possible systematic interpretation is therefore to include *Muehlenbeckia* in *Fallopia* (priority name). A second possible solution is to subdivide *Fallopia* into more genera (at least two). Taking

into consideration that *Fallopia* and *Muehlenbeckia* have always been considered as being quite separate entities and that *Fallopia* has often been subdivided into more genera, it is here recommended to take the second option, and also to retain *Homalocladium*.

Reynoutria Houtt. (3-7 spp.)
≡ *Fallopia* Adans. sect. *Reynoutria* (Houtt.) Ronse Decr.
T: *Reynoutria japonica* Houtt.

On the basis of the morphological characters the genus *Reynoutria* has often been included within the *Fallopia* (eg. Hedberg, 1946; Ronse Decraene & Akeroyd, 1988; Bailey & Stace, 1992), also on account of the presence of hybrids (Bailey, 1988; Bailey & Stace, 1992; Bailey, 2001; Bailey & Spencer, 2003); in the past they have been united also under the generic name *Reynoutria* or other names erroneously retained as having priority. Other authors (eg. Nakai, 1926; Roberty & Vautier, 1964; Webb & Chater, 1963; Webb, 1964, 1993; Holub, 1971; Haraldson, 1978; Brandbyge, 1993; Mandák *et al.*, 2004; Padula *et al.*, 2008), instead, have considered them as being autonomous. *Reynoutria* is a quite distinct morphological unit within the *Fallopia* complex (see Kim & Park, 2000) and the present molecular results show how it could, or better still, should be maintained separate at genus level. The traditional differentiating characters are listed below.

Fallopia. Stems scandent; flowers hermaphrodite; styles short; stigmas capitate or peltate, however, in *F. koreana* flowers dioecious and stigmas fimbrate (Kim *et al.*, 2000b) -nevertheless in the protologue (Oh & Kim, 1996) peltate stigmas are mentioned but no reference is made to dioecy-; achenes with beak absent or very short; x = 10, 11.

Reynoutria. Stems erect and robust; flowers functionally unisexual (hermaphrodite and female plants); styles long; stigmas fimbrate; achenes with beak evident; x = 11.

The genus *Reynoutria* is polyploid and extremely variable, both in the morphological characters and in the chromosome number. Consequently, there is a high degree of taxonomic confusion and difficulty in determining the limits between species (Kim & Park, 2000); furthermore infraspecific hybridization is relatively common (Bailey & Stace, 1992). The two species universally recognized are ***R. japonica*** Houtt. and ***R. sachalinensis*** (F.Schmidt) Nakai, however, there are numerous other taxa, variously synonymized or reduced to variety rank, such as *R. sachalinensis* (F.Schmidt) Nakai var. *intermedia* (Tatew.) Tatew.

Reynoutria japonica Houtt. var. *compacta* (Hook.f.) Moldenke is a dwarf taxon of the high peaks of Japan and Korea (but probably exclusive to Monte Fuji), smaller than the typical var. *japonica* and often with the inflorescence tinged with red (Ohwi, 1965; Stace, 1991, 1997). It is frequently treated at variety rank (eg. Ohwi, 1965; Conolly, 1977; Stace, 1989, 1991, 1997; Bailey & Stace, 1992; Pyšek *et al.*, 2002; Mandák *et al.*, 2004) or, sometimes, synonymized completely with the type of the species (Kim & Park, 2000; Li & Park, 2003). It is the first colonizer of volcanic lavas, where it forms colonies which expand in circles and gradually thin out towards the center (Adachi *et al.*, 1996). It is cultivated in Europe and sometimes is found in nature as a casual alien. Transplanted at lower altitudes it maintains its characteristics (Shiosaka & Shibata, 1993); furthermore, its *rbc*L sequence shows a greater affinity with *R. sachalinensis* rather than with *R. japonica* var. *japonica*; also the attempts of hybridization by Bailey & Stace (1992) show a certain homology between its chromosomes and those of *R. sachalinensis* rather than with those of *R. japonica* var. *japonica*. Consequently, it may merit species rank, for which a valid combination already exists: ***R. compacta*** (Hook.f.) Nakai.

In the 'Flora of China', Li & Park (2003) retain *Reynoutria* and *Fallopia* as distinct; although the choice of retaining *Fallopia forbesii* (Hance) Yonekura & H.Ohashi within *Fallopia* is nevertheless curious. This species has been re-evaluated by Yamazaki (1994) and Yonekura & Ohashi (1997) and corresponds to the majority of the Chinese and Korean populations of *R. japonica* s.l.: it is very similar to *R. japonica* s.s., however, it is clearly distinct due to the shape of the leaves (Kim & Park, 2000) and, above all, due to the presence of thick, rigid hairs on the lower surface of the leaves (personal observations G.G.), strictly absent in *R. japonica* and *R. compacta*. Its correct name therefore is ***R. forbesii*** (Hance) T.Yamaz.

Yonekura & Ohashi (1997) included within the variability of *Reynoutria japonica* two further taxa, both endemic to Japan and never introduced outside of their area of origin: *Fallopia japonica* (Houtt.) Ronse Decr. var. *hachidyoensis* (Makino) Yonekura & H.Ohashi and *Fallopia japonica* (Houtt.) Ronse Decr. var. *uzenensis* (Honda) Yonekura & H.Ohashi (≡ *Reynoutria japonica* Houtt. var. *uzenensis* Honda) (see Bailey, 2003). The former has shiny leaves while the latter has short rigid hairs on the lower surface of the blades, a character which is absent in *R. japonica*. Preliminary studies based on RAPD (Hollingsworth & Bailey, 2000) and on the plastidial sequence (Inamura *et al.*, 2000) show an elevated variability of the native population of *Reynoutria japonica* s.l., which would lead one to think of the existance of further species. While waiting for their correct systematic interpretation the authors think it is better to treat these taxa at species rank: ***R. hachidyoensis*** (Makino) Honda and ***R. uzenensis*** (Honda) Honda.

R. bohemica Chrtek & Chrtková, pro hybr., originated from the hybridization between *R. japonica* and *R. sachalinensis* while ***R. ×mizushimae*** Yokouchi ex T.Shimizu (Shimizu, 1997) is the hybrid of *R. uzenensis* and *R. sachalinensis*.

Fallopia Adans. (ca. 15 spp.)
T: *Polygonum scandens* L. (≡ *Fallopia s.* (L.) Holub)
= *Pleuropterus* Turcz.
T: *P. cordatus* Turcz., nom. illeg. (≡ *Fallopia multiflora* (Thunb.) Haraldson)

Although in this study only a few species of the genus *Fallopia* have been considered, it is nevertheless possible to make some observations on its infrageneric subdivision. The genus is presently articulated in 3 sections (excluding sect. *Reynoutria*), distinguished on the basis of the habit and the shape of the stigma and trichomes (Holub, 1971; Haraldson, 1978). Only future studies, which should include also *F. koreana*, *F. denticulata* and the species of the sect. *Paragonum*, may clarify the real relationships between them.

Fallopia Adans. sect. ***Fallopia*** (8 spp.)
T: *Polygonum scandens* L. (≡ *Fallopia s.* (L.) Holub)
= *Bilderdykia* Dumort.
≡ *Tiniaria* (Meisn.) Rchb.
≡ *Polygonum* L. sect. *Tiniaria* Meisn.
T: *B. convolvulus* (L.) Dumort. (≡ *Fallopia c.* (L.) Á.Löve)

It appears to be homogeneous both from a morphological (Kim *et al.*, 2000c) and chemical (Kim *et al.*, 2000a) viewpoint and the present tree confirms that it is monophyletic.

Fallopia Adans. sect. ***Paragonum*** Haraldson (2 spp.)
T: *F. cilinodis* (Michx.) Holub

Haraldson (1978) separated the sect. *Paragonum* from the sect. *Fallopia*, on the basis of the presence of filiform, unicellular and papillose trichomes unique within

the genus; it includes two species, the Asian *F. cynanchoides* (Hemsl.) Haraldson and the American *F. cilinodis* (Michx.) Holub. Furthermore, in contrast to the sect. *Fallopia*, characterized by an annual habit, capitate stigma and x = 10, it has a perennial habit and, at least in *F. cynanchoides*, a peltate stigma and x = 11 (Kim *et al.*, 2000a). The studies on flavonoids by Kim *et al.* (2000a) confirm the separation. However, in the present study it was not possible to include this species.

Fallopia Adans. sect. ***Pleuropterus*** (Turcz.) Haraldson (4-5 spp. or more)
≡ *Pleuropterus* Turcz.
≡ *Polygonum* L. sect. *Pleuropterus* (Turcz.) Benth. & Hook.
T: *P. cordatus* Turcz., nom. illeg. (≡ *Fallopia multiflora* (Thunb.) Haraldson)
= *Fallopia* Adans. sect. *Sarmentosae* Holub, non *Fagopyrum* Mill. sect. *Sarmentosa* I.Grinț. nom. illeg.
T: *F. baldschuanica* (Regel) Holub

This section, composed of plants with a perennial habit, appears to be hetergeneous both from a morphological, chemical and cytological viewpoint: on the basis of the flavonoids and chromosome number two groups may be distinguished (Kim *et al.*, 2000b). The first, with x = 11 and capitate and smooth stigmas, includes *F. multiflora* (Thunb.) Haraldson (and its eventual segregrates) and *F. ciliinervis* (Nakai) K.Hammer. The second, with x = 10, includes *F. baldschuanica* (Regel) Holub (= *F. aubertii* (L.Henry) Holub), with strongely papillose and sometimes peltate stigmas, and *F. koreana* B.U.Oh & J.G.Kim, with fimbrate stigmas and dioecious flowers (characters in common with *Reynoutria*); nevertheless, in the protologue peltate stigmas are mentioned and dioecy is not referred to (Oh & Kim, 1996). Also *F. denticulata* (C.C.Huang) Holub may belong to one of the two groups in this section. On the basis of that data and the present results this section may not be monophyletic and *Pleuropterus* s.s. may merit genus rank, as was already proposed by Nakai (1914, 1926).

The name published by Grințescu is invalid (Haraldson, 1978), as in his new section *Polygonum multiflorum*, the type of *Polygonum* sect. *Pleuropterus*, is also included (ICBN art. 52.1: McNeill *et al.*, 2006); Holub (1971) explicitly excludes *P. multiflorum* and therefore his section is legittimate and is to be considered as new, not a new combination (ICBN art. 58.1: McNeill *et al.*, 2006).

×***Reyllopia*** Holub (1 sp.)
= *Fallopia* Adans. × *Reynoutria* Houtt.

The only hybrid (sterile) recognized in nature between these two genera is that between male individuals of *Fallopia baldschuanica* and female individuals of *Reynoutria japonica*. Every year the plants of *Reynoutria japonica* produce a remarkable quantity of seeds of this hybrid, however, only a negligible quantity manages to germinate (Bailey & Stace, 1992; Bailey, 2001). The seeds have been recognized in great Britain since 1983 (Bailey & Conolly, 1984), while finding of the first plant germinated in nature, also in Great Britain, dates to 1987 (Bailey, 1988); observations have followed in the Czech Republic, Germany, Hungary and Norway (Bailey, 2001) and again in the British Isles (Bailey & Spencer, 2003).

The following new combination is here proposed in the nothogenus ×*Reyllopia*, appropriately foreseen by Holub (1998).

×***Reyllopia conollyana*** (J.P.Bailey) Galasso, **comb. nov.** (bas.: *Fallopia* ×*conollyana* J.P.Bailey, *Watsonia*, 23 (4): 539. 2001)(= *Fallopia baldschuanica* (Regel) Holub ♂ × *Reynoutria japonica* Houtt. ♀)

Muehlenbeckia Meisn. (22 spp.)
T: *M. australis* (G.Forst.) Meisn.

Homalocladium (F.Muell.) L.H.Bailey (1 sp.)
≡ *Polygonum* L. sect. *Homalocladium* F.Muell.
T: *Polygonum platycladum* F.Muell. (≡ *Homalocldaium p.* (F.Muell.) L.H.Bailey)

The monotypic genus *Homalocladium*, characterized by flattened stems forming cladodes, is often included in *Muehlenbeckia* (eg. Brandbyge, 1993). The present tree, even if based on a few species, does not show it to be linked to *Muehlenbeckia*; it seems appropriate, however, also taking into consideration the particular morphology of the stems, that it should be retained at genus rank.

Incertae sedis
Genus included: *Knorringia*.

Knorringia (Czukav.) Tzvelev [1987] (1-2 spp.)
≡ *Knorringia* (Czukav.) Hong [1989], comb. superfl.
≡ *Polygonum* sect. *Knorringia* Czukav.
≡ *Aconogonum* sect. *Knorringia* (Czukav.) Soják
T: *Knorringia sibirica* (Laxm.) Tzvelev

The genus *Knorringia*, segregated from *Aconogonum* (Tzvelev, 1987; Hong, 1989) and placed by Hong (1989) within the tribe Coccolobeae, also belongs to the Polygoneae (Liu *et al.*, 2007). In fact, it has the same tepal nervature and similar pollen morphology; furthermore it greatly resembles *Fallopia* due to the morphology of the pollen, the structure of the exocarp, the presence of the anthraquinone and the chromosome number; the style and the stigma instead are similar to *Reynoutria* (Hong, 1989; Wang & Feng, 1994; Ronse Decraene *et al.*, 2000; Zhou *et al.*, 2002). In the description of this genus the presence of extrafloral nectaries is never mentioned and this character, if confirmed, could favour its inclusion within the subtribe Polygoninae.

Tribus **Persicarieae** Dumort.
(clades I + III)

Clades I and III taken together correspond well to the tribe Persicarieae, as was proposed by Ronse Decraene & Akeroyd (1988) however, excluding *Fagopyrum* and related genera. It is characterized by:

1) tepals with three main nervatures which depart from the base,

2) epidermic cells rectangular to elongate with straight or undulating anticlinal walls, cuticles smooth or striate in longitudinal direction and often continuous (type I sensu Hong *et al.*, 1998),

3) conspicuous nectaries, free or variously fused; trichomes or papillae usually present.

Actually the tree presented here does not support, nor exclude, a link between clades I and III, however, the morphological affinities, highlighted several times in the literature, are remarkable and also the phylograms by Liu *et al.* (2007), Sun *et al.* (2008), Kim & Donoghue (2008), Sanchez & Kron (2008), as well as the abstract by Kim *et al.* (2005) confirm the monophyletic nature of the Persicarieae. Nevertheless, the two clades are quite distinct and it is proposed here to treat them at subtribe rank.

Subtribus **Persicariinae** (Dumort.) Galasso, Soldano & Banfi, **subtrib. nov.**
Bas.: *Persicarieae* Dumort., *Fl. Belg.*: 17. 1827.
(clade I, bootstrap 95%)
Genus included: *Persicaria*.

The only genus belonging to this subtribe is characterized by a peculiar morphology of the surface of the pollen granules, which is invariably reticulate but has smooth and not granulate muri (Hedberg, 1946; Park, 1988; Hong & Hedberg, 1990; Hong, 1992; Wang & Feng, 1994). The characteristics of the surface of the achenes are also shared by all the subtribes (Ronse Decraene *et al.*, 2000). Furthermore, the tepals are fused for almost 1/3, thus differing from Koenigiinae in which they are free or fused only at the base (Ronse Decraene & Akeroyd, 1988). Finally, the stamens are not constant in number and the nectaries are not themselves fused nor fused with the stamens to form a disc, except in *Persicaria* sect. *Cephalophilon* (Ronse Decraene & Akeroyd, 1988; Ronse Decraene & Smets, 1991; Hong, 1993); the latter section, based on Kim & Donoghue (2008), results as being the sister group of all the genus.

Persicaria (L.) Mill. (ca. 100 spp.)
≡ *Polygonum* L. [unranked] *Persicaria* L.
T: *Persicaria maculosa* Gray (≡ *Polygonum persicaria* L.)

The number and arrangement of the pollen apertures within the genus *Persicaria* allow 4 typologies to be recognized, which are divided into 6 monophyletic groups identified in the dendrogram and here considered at the level of section; these are quite disctinct from each other also on the basis of the macromorphology of the inflorescence and the presence of prickles on the stem.

- Typology 1 ("species *virginiana-filiformis* = sect. *Tovara*"): pollen grains 12-porate with pores arranged as the edges of a cube; stem without prickles; inflorescence linear (strictly spicate and interrupted) with two persistent styles, obliquely bent backwards and hardened at maturity; reduced number of tepals and stamens.
- Typology 2 ("species *runcinata-nepalensis* = sect. *Cephalophilon*"): pollen grains 3(-8)-colpate; stem without prickles; inflorescence capitate.
- Typology 3 ("species *odorata-acuminata* = sect. *Persicaria*" + "species *bungeana* = sect. *Truelloides*" + "species *senticosa-thunbergii* = sect. *Echinocaulon*"): pollen grains polyporate; inflorescence spicate and flexible and stem without prickles in sect. *Persicaria*; inflorescence always spicate but presence of prickles on stem in sect. *Truelloides*; inflorescence capitate and prickles along stem in sect. *Echinocaulon*.
- Typology 4 ("species *amphibia* = sect. *Amphibiae*"): pollen grains 30-porate with pores arranged as the edges of a pentagonal dodecahedron; stem without prickles and inflorescence spicate and relatively rigid, with robust rhizomes.

Persicaria (L.) Mill. sect. ***Persicaria*** (ca. 60 spp.)
("species *odorata-acuminata*", bootstrap 75%)
T: *Persicaria maculosa* Gray (≡ *Polygonum persicaria* L.)
= *Polygonum* L. sect. *Amblygonon* Meisn. [1826]
≡ *Persicaria* (L.) Mill. sect. *Amblygonon* (Meisn.) Tzvelev
≡ *Amblygonum* Rchb. [1837]
T: *Polygonum orientale* L. (≡ *Persicaria o.* (L.) Spach)
= *Lagunea* Lour. [1790], non *Laguna* Cav. [1786], nom. illeg.
≡ *Goniaticum* Stokes [1812]

T: *L. cochinchinensis* Lag. (= *Persicaria orientalis* (L.) Spach)
= *Persicaria* (L.) Mill. sect. *Hydropiper* M.A.Hassan
T: *P. hydropiper* (L.) Delarbre
= *Persicaria* (L.) Mill. sect. *Planocarpon* M.A.Hassan
T: *P. lapathifolia* (L.) Delarbre

The generally accepted infrageneric classification of *Persicaria* is therefore confirmed in outline by the present cladogram; the differences lie in the inclusion of the sect. *Amblygonon* in the sect. *Persicaria* and in the addition of the sect. *Amphibia* and *Truelloides*. The section *Amblygonon* (not *Amblygonum*!) was established due to the position of the cotyledons, which are incumbent rather than accumbent. Nevertheless, as already noted by Danser (1927) and by Hedberg (1946), this character may vary also within the same individual and therefore is not of taxonomic value. The only species considered in the present study as belonging to this section is *Persicaria orientalis*, which falls in the cladogram within the core of *Persicaria* s.s. (species *odorata-acuminata*) thus confirming the systematic invalidity of this section. Regarding the sections *Amphibiae* and *Truelloides* refer to what is written below.

Other two sections have been described within the genus *Persicaria*, sect. *Hydropiper* and sect. *Planocarpon* (Hassan, 1997), both included within sect. *Persicaria* by the present tree. The latter however, subsequent to further analyses covering a greater number of species may be re-evaluated, together with sect. *Amblygonon*, at the rank of series and with a different boundary.

One species of this section, endemic to the Galápagos Islands (Caruel, 1889; Wiggins, 1971), is still lacking a combination in *Persicaria*. This is proposed below.

Persicaria galapagensis (Caruel) Galasso, **comb. nov.** (bas.: *Polygonum galapagense* Caruel, *Atti Reale Accad. Lincei. Rendiconti*, s. 4, 5 (1): 624. 1889)

Persicaria (L.) Mill. sect. ***Amphibia*** Tzvelev [1987] (1 sp.)
("species *amphibia*", bootstrap 99%)
T: *Persicaria amphibia* (L.) Delarbre
= *Persicaria* (L.) Mill. [unranked] *Amphibiae* Small [1933]
T: *Persicaria muhlenbergii* (S.Watson) Small (=*Persicaia amphibia* (L.) Delarbre)

Persicaria amphibia has always been related to all the other species of sect. *Persicaria*, nevertheless it has some characteristics (pollen typology and the presence of a robust rhizome) which place it in a particular position. It was Small (1933) that first recognized its isolated position, while Tzvelev (1987) proposed a new section ad hoc. The analyses of some nucleotide sequences by Kim & Donoghue (2005), Kwak *et al.* (2006) and Kim & Donoghue (2008) confirm its isolated position; the further results presented here indicate that it merits its own section.

This taxon, widely spread throughout the boreal hemisphere and naturalized in Mexico, South America and South Africa, is a highly polymorphic species: there are acquatic-adapted forms and terrestrial-adapted forms, each one being highly variable. For instance, in North America two extreme ecotypes are recognized, one acquatic (var. *stipulacea* (N.Coleman) H.Hara, it is not stated that it is the priority epithet) and one emergent or terrestrial (var. *emersa* (Michx.) J.C.Hickman) linked by an almost continuous series of morphological intermediates (Turesson, 1961; Mitchell, 1968, 1976); the Eurasian plants (var. *amphibia*) are intermediate between the two American extremes, however, they are sometimes indistinguishable (Mitchell & Dean, 1978). There are not therefore sufficient biosystematic reasons for recognising the formal value of the various morphotypes, analogously to the recent treatment in the 'Flora of North America' (Hinds & Freeman, 2005).

Persicaria (L.) Mill. sect. ***Cephalophilon*** (Meisn.) H.Gross (ca. 15 spp.)
("species *runcinata-nepalensis*", bootstrap 99%)
≡ *Polygonum* L. sect. *Cephalophilon* Meisn.
≡ *Cephalophilon* (Meisn.) Spach [1841], non *Cephalophilum* Meisn. ex Börner [1912]
≡ *Truellum* Houtt. sect. *Cephalophilon* (Meisn.) Soják
T: *Polygonum nepalense* Meisn. (≡ *Persicaria n.* (Meisn.) H.Gross)
= *Ampelygonum* Lindl. [1838]
T: *A. chinense* (L.) Lindl. (≡ *Persicaria c.* (L.) H.Gross)

As far as is known a recent systematic revision of this section is lacking. Firstly, the species included in it and for which combinations are lacking are the following; others may be added subsequently.

Persicaria greuteriana Galasso, **nom. nov.** (bas.: *Polygonum wallichii* Meisn., *Monogr. Polyg.*: 83. 1826, non *Persicaria wallichii* Greuter & Burdet, *Willdenowia*, 19 (1): 41. 1989). This species may be included within the variability of *P. microcephala*.

Persicaria malaica (Danser) Galasso, **comb. nov.** (bas.: *Polygonum malaicum* Danser, *Bull. Jard. Bot. Buitenzorg*, ser. 3, 8: 218. 1927). This species may be included within the variability of *P. chinensis*.

Persicaria strindbergii (J.Schust.) Galasso, **comb. nov.** (bas.: *Polygonum strindbergii* J.Schust., *Bull. Herb. Boiss.*, sér. 2, 8: 712. 1908)

Persicaria umbrosa (Sam.) Galasso, **comb. nov.** (bas.: *Polygonum umbrosum* Sam. in Hand.-Mazz., *Symb. Sin.*, 7: 182. 1929)

Persicaria (L.) Mill. sect. ***Echinocaulon*** (Meisn.) H.Gross (ca. 21 spp.)
("species *senticosa-thunbergii*", bootstrap 93%)
≡ *Polygonum* L. sect. *Echinocaulon* Meisn.
≡ *Echinocaulon* (Meisn.) Spach [1841], non Kütz. [1843]
T: *Polygonum sagittatum* L. (≡ *Persicaria s.* (L.) H.Gross ex Nakai)
= *Truellum* Houtt.
T: *Truellum japonicum* Houtt. (= *Persicaria senticosa* (Meisn.) Nakai)
= *Chylocalyx* Hassk.
T: *Chylocalyx perfoliatus* (L.) Hassk. (≡ *Persicaria p.* (L.) H.Gross)

The section *Echinocaulon*, sometimes considered at generic rank under the name *Truellum* (Soják, 1974), is characterized by the presence of recurved prickles on the angles of the stems, on the petioles and on the main nervatures of the abaxial surface of the leaves, by the often scandent habit and by the base of the leaves being hastate or sagittate; it appears monophyletic from a macromorphological point of view (Park, 1988). Nevertheless, except for the prickliness, which is sometimes absent as in *Persicaria nogueirae* S.Ortíz & Paiva (Ortíz & Paiva, 1999), its species are very variable with regard to other characters such as the chemistry of the flavonoids (Park, 1987), the trichomes, the flowers and the achenes (Kim *et al.*, 2001); instead, the pollen grains (Hedberg, 1946) and the other characters such as the morphology of the epidermis of the tepals (Hong *et al.*, 1998) are indistinguisable from those of sect. *Persicaria*. Regarding *Persicaria bungeana*, sometimes considered as belonging to this section (Park, 1988), even if atypical, refer to the description in the present study of sect. *Truelloides*. In *Persicaria perfoliata* the perianth becomes fleshy in fruit and for this reason it is sometimes considered as belonging to the genus *Chylocalyx*.

Some species of the section *Echiniocaulon* are still lacking a combination in *Persicaria*. These are proposed below.

Persicaria brachypoda (Baker) Galasso, **comb. nov.** (bas.: *Polygonum brachypodum* Baker, *J. Linn. Soc. Bot.*, 20: 239. 1883)
Persicaria clarkei (C.W.Park) Galasso, **comb. nov.** (bas.: *Polygonum clarkei* C.W.Park, *Brittonia*, 38 (3): 217. 1986)
Persicaria rubricaulis (Cham.) Galasso, **comb. nov.** (bas.: *Polygonum rubricaule* Cham., *Linnaea*, 8: 130. 1833)
Persicaria stelligera (Cham.) Galasso, **comb. nov.** (bas.: *Polygonum stelligerum* Cham., *Linnaea*, 8: 131. 1833)

Persicaria (L.) Mill. sect. ***Tovara*** (Adans.) H.Gross (3 spp.)
("species *virginiana-filiformis*", bootstrap 99%)
≡ *Tovara* Adans., nom. rej.
T: *Tovara virginiana* (L.) Raf. (≡ *Persicaria v.* (L.) Gaertn.)
= *Antenoron* Raf.
T: *Antenoron racemosum* Raf. (= *A. virginianum* (L.) Roberty & Vautier ≡ *Persicaria virginiana* (L.) Gaertn.)

This section, morphologically distinct from the others, is distributed primarily in eastern Asia and eastern North America where it is represented by three species with high affinity but well separated by morphology (Park *et al.*, 1992), by the chemistry of the flavonoids (Mun & Park, 1995) and by the ITS sequences (Youngbae *et al.*, 1997).

Persicaria (L.) Mill. sect. ***Truelloides*** Tzvelev (1 sp.)
("species *bungeana*")
T: *Persicaria bungeana* (Turcz.) Nakai

According to Park (1988) *P. bungeana* could belong to sect. *Echinocaulon* as it has recurved prickles along the stem. Nevertheless, it possesses some characters that differentiate it from the other species of the same section and show greater affinities to that of sect. *Persicaria* (Hedberg, 1946; Park, 1988): the leaves are cuneate at the base (not hastate or cordate), the ocreolas are funnel-shaped, the inflorescence elongate (not capitate), the prickles along the stem are scarce. For this reason many authors, including Haraldson (1978), Hong *et al.* (1998), Ronse Decraene *et al.* (2000) and the same Soják (1974) who was the first to reconsider the genus *Truellum*, ascribed it to sect. *Persicaria*, while Tzvelev (1987, 1989) establised a section ad hoc nominated *Truelloides*. Preliminary molecular analyses of the sect. *Echinocaulon*, based on the nucleotide sequences (Yoo & Park, 2001), confirm the isolated position of this species and its sister relationship with sect. *Persicaria*. The results presented here provide further confirmation of this conclusion.

Subtribus **Koenigiinae** Dammer
(clade III, bootstrap 99%)
Genera included: *Aconogonum*, *Bistorta*, *Koenigia*, *Rubrivena*.

The genera belonging to this subtribe share a peculiar morphology of the surface of the pollen grains: spinulose, microspinulose or granulate (Hedberg, 1946; Hong & Hedberg, 1990; Hong, 1991a, 1992, 1993; Hedberg, 1997; Zhou *et al.*, 2004). In *Koenigia* it is spinulose, with spinules (of variable length in diverse individuals) intermingled with microspinules; except for *K. delicatula* (Meisn.) H.Hara subsp. *relicta* Hedberg (see also Hedberg, 1988), which has a reticulate surface without spinules but with granulate muri, analogous to *Rubrivena*. In *Aconogonum* and *Bistorta* it is microspinulose, with the exception of *A. campanulatum* (Hook.f.) H.Hara (see also Hong, 1991b), whose long-style plants have very long microspinules similar to those of *Koenigia*. In *Rubrivena* it is reticulate, as in the Persicariinae, however, in contrast to this, the muri are gra-

nulate; this represents a unique character in the Polygonaceae, shared only by *Koenigia delicatula* subsp. *relicta*. The number and arrangement of the apertures, instead, varies considerably and is not of particular taxonomic significance at genus level, ranging from 3-colpate to polycolpate to polyporate (Hong & Hedberg, 1990); nevertheless, *Bistorta* is distinguished from the others in that it always has 3-colporate pollen.

Furthermore, the tepals of Koenigiinae are free or fused only at the base, while in the Persicariinae they are fused for circa 1/3 (Ronse Decraene & Akeroyd, 1988). Finally, the nectaries fuse with the base of the stamens to form a disc, although incomplete in *Bistorta* (Ronse Decraene & Akeroyd, 1988; Ronse Decraene & Smets, 1991; Hong, 1993). The androecium is constantly octameric (Král, 1985; Ronse Decraene *et al.*, 2000), apart from in *Koenigia* where it is reduced (Ronse Decraene, 1989; Hedberg, 1997).

An alternative systematic solution to that put forward here is that of maintaining united the genera *Aconogonum*, *Koenigia* and *Rubrivena*, with the priority name *Koenigia*. Taking into consideration the fact that *Koenigia* has always been kept distinct from *Aconogonum* and that this union would mean numerous new nomenclatural combinations, it is recommended here that the three genera be retained distinct.

Aconogonum Rchb. (ca. 25 spp.)

≡ *Polygonum* L. sect. *Aconogonon* Meisn.

T: *Polygonum divaricatum* L. (≡ *Aconogonum d.* (L.) Nakai) designated by Roberty & Vautier (1964), non *A. alpinum* (L.) Schur designated by Král (1985)

In relation to the spelling of the name of this genus see Galasso *et al.* (2006).

Its limits are well defined from a macromorphological and palynological point of view and only *Knorringia* and *Rubrivena* must be separated from this genus. Nevertheless, it should be noted that in *A. campanulatum* (Hook.f.) H.Hara, the only species of *Aconogonum* that shows the phenomenon of heterostylism (Conolly, 1977; Hong, 1991b; Hong, 1993), the long-styled plants have pollen with elongate microspinules similar to the spinules of *Koenigia* (Hong & Hedberg, 1990; Hong, 1991b; Hedberg, 1997).

Koenigia L. (6 spp.)

T: *K. islandica* L.

= *Polygonum* L. sect. *Eleutherospermum* Hook.f.

T: *Polygonum delicatulum* Meisn. (≡ *Koenigia delicatula* (Meisn.) H.Hara)

The genus *Koenigia* has long been considered monotypic. It should, however, be extended to include the species that were placed within *Polygonum* L. sect. *Eleutherospermum* Hook.f., that share the same characteristically spinulose pollen type (Hedberg, 1946; Měsíček & Soják, 1973; Hedberg, 1997; Zhou *et al.*, 2004). As already mentioned above, *K. delicatula* (Meisn.) H.Hara is a very particular species, with pollen dimorphism: the nominal subspecies has spinulose pollen, typical for this genus, while the subsp. *relicta* Hedberg has reticulate pollen with granulate muri, typical of the genus *Rubrivena* (Hedberg, 1988; Hong & Hedberg, 1990).

The dendrogram shows *Koenigia* as monophyletic, analogously to the results presented by Liu *et al.* (2007), and sister to *Aconogonum*; in its turn, *Rubrivena* is sister to both the latter genera.

Rubrivena M.Král (2 spp.)

≡ *Persicaria* (L.) Mill. sect. *Rubrivena* (M.Král) S.P.Hong

T: *R. polystachya* (Wall. ex Meisn.) M.Král (≡ *Polygonum polystachyum* Wall. ex Meisn.; ≡ *Aconogonum polystachyum* (Wall. ex Meisn.) Small [1922]; ≡

Aconogonum polystachyum (Wall. ex Meisn.) M.Král [1969], comb. superfl.; ≡ *Aconogonum polystachyum* (Wall. ex Meisn.) Haraldson [1978], comb. superfl.; ≡ *Persicaria wallichii* Greuter & Burdet, ≡ *Persicaria polystachya* (Wall. ex Meisn.) H.Gross [1913], non Opiz [1852])

The species *Polygonum polystachyum* has been variously attributed to the genera *Aconogonum* (see Král, 1969; Haraldson, 1978), *Persicaria* (see Hong & Hedberg, 1990; Ronse Decraene & Smets, 1991; Hong, 1993; Hong *et al.*, 1998; Ronse Decraene *et al.*, 2000) or to its own genus *Rubrivena* (Král, 1985). Actually, as highlighted in the studies listed and as has been stated previously, it shows macromorphological aspects typical of *Aconogonum*, while the pollen characters show affinities to *Persicaria*. Nevertheless, it is differentiated from Persicariinae as the crests of the muri are granulate and not smooth; also the epidermic cells of the achenes differ from those of *Persicaria* (Hong *et al.*, 1998). Furthermore, it differs from *Aconogonum* s.s. in having long styles (Král, 1985): *Rubrivena* is heterostylous, as is *Aconogonum campanulatum* (Conolly, 1977; Hong, 1991b; Hong, 1993), nevertheless, it differs from the latter species as even the short-styled plants have styles longer than *Aconogonum*.

On the basis of the present results, this species does not appear to be related to *Persicaria*, but rather to *Aconogonum*; in particular it results as being sister of the pair *Aconogonum*/*Koenigia*. The retention of the genus *Rubrivena* appears more than justified. *R. pinetorum*, strictly related to *R. polystachya* (Hong, 1993), is added to the genus, as already suggested by Král (1985); the new combination is proposed below.

Rubrivena pinetorum (Hemsl.) Galasso, Labra & F.Grassi, **comb. nov.** (bas.: *Polygonum pinetorum* Hemsl., *J. Linn. Soc. Bot.*, 26: 345. 1891)

Bistorta (L.) Scop. (ca. 50 spp.)

≡ *Polygonum* L. [unranked] *Bistorta* L.

T: *Bistorta officinalis* Delarbre (≡ *Polygonum bistorta* L.)

On the basis of the cladograms by Lamb Frye & Kron (2003), Kim & Donoghue (2008) and the results presented here the genus *Bistorta*, being homogeneous from a morphological and palynological point of view, appears as sister of the (*Aconogonum*/*Koenigia*)/*Rubrivena* group.

Tribus **Fagopyreae** Yonek.

= cohors Fagopyrastreae Roberty & Vautier [According to Roberty & Vautier (1964) the cohors is a rank between subtribe and genus]

(clades IV + IX)

Genera included: *Fagopyrum*, *Harpagocarpus* and, probably, *Eskemukerjea* and *Pteroxygonum*.

The genus *Fagopyrum* and the genera correlated with it have morphological particularities that differentiate them both from the Persicarieae and the Polygoneae. They were traditionally related to *Fallopia* due to the superficial similiarity (Gross, 1913a); nevertheless, on the basis of some floral characters (stamen morphology, tepal nervation and nectary typology) Ronse Decraene & Akeroyd (1988) included them in the Persicarieae (at the base), while, again on the basis of the nectaries, Ronse Decraene & Smets (1991) placed them at the base both of the Persicarieae and the Polygoneae. It should also be noted that the tepal nervation is not constant in all of the species but in some it is more similar to Polygoneae and in others to Persicarieae.

The morphology of the epidermic cells of the tepals does not help in clarifying the situation: *Fagopyrum* sect. *Polygonopsis*, *Harpagocarpus* and *Pteroxygonum*

have type I cells (sensu Hong *et al.*, 1998) analogously to Persicarieae, while type III (as in *Oxygonum*) are found in *Fagopyrum* sect. *Fagopyrum* and *Eskemukerjea*. It is probable that this similarity between *Fagopyrum* sect. *Fagopyrum* and *Oxygonum* is only due to homoplasy (Hong *et al.*, 1998), as both these genera show significant differences in other characters, such as the tepal vascularization and the typology of the nectary. The morphology and anatomy of the achenes (Ronse Decraene *et al.*, 2000) also show particularities not shared by the other tribes.

The present results do not correlate *Fagopyrum* to any of the other genera of the Polygonoideae; therefore, the best systematic solution seems to be to consider an own tribe, according to Yonekura (Iwatsuki *et al.*, 2006), which probably should be placed at the base of the Polygoneae + Persicarieae as was already suggested by Ronse Decraene & Smets (1991), or only the Persicarieae (Kim & Donoghue, 2008; Sun *et al.*, 2008). Marek (1958) previously suggested placing this genus in its own subfamily, while Ronse Decraene *et al.* (2000) seemed more inclined to assign it to its own tribe.

The genera *Eskemukerjea*, *Harpagocarpus* and *Pteroxygonum* are, according to the authors, variously retained as distinct or included in *Fagopyrum* s.l. Among the numerous phylogenetic studies on *Fagopyrum* based on DNA sequences (Yasui & Ohnishi, 1996; Ohnishi & Matsuoka, 1996; Ohsako & Ohnishi, 1998; Yasui & Ohnishi, 1998a, 1998b; Ohsako & Ohnishi, 2000; Ohsako *et al.*, 2001, 2002; Yamane *et al.*, 2003; Sun *et al.*, 2008), only Ohsako *et al.* (2001) and Sun *et al.* (2008) have to date taken into consideration two of these satellite genera, respectively *Eskemukerjea* and *Pteroxygonum*. Their results reveal that neither of these genera are strictly related to *Fagopyrum* s.s., however, the results do not allow them to be collocated precisely within the Polygonaceae. In addition the present tree confirms the autonomy of *Eskemukerjea*, which may also not belong to this tribe. It would be useful in future research to include also the other genera segregated from *Fagopyrum* utilizing the same sequences in order to clarify their reciprocal relationships and verify the monophyly of Fagopyreae, which is nevertheless most probabable on the grounds of morphological similarities.

Eskemukerjea Malick & Sengupta (1 sp.)
(clade IV)

T: *Eskemukerjea nepalensis* Malick & Sengupta (= *Eskemukerjea megacarpa* (H.Hara) H.Hara ≡ *Fagopyrum megacarpum* H.Hara)

A monotypic genus from Nepal, not recognized by Hong *et al.* (1998) but clearly distinct from *Fagopyrum* s.s. on the basis of the present tree and the previous study by Ohsako *et al.* (2001); as stated it may also not belong to this tribe.

Fagopyrum Mill. (ca. 19 spp.)
(clade IX, bootstrap 96%)

T: *Fagopyrum esculentum* Moench, typ. cons. (≡ *Polygonum fagopyrum* L.)

As shown both by the morphology and by the isozymes and DNA (Ohnishi & Matsuoka, 1996; Yasui & Ohnishi, 1998a, 1998b; Ohsako *et al.*, 2001), the genus *Fagopyrum* s.s. is monophyletic and composed of two groups of species: "*cymosum*-group" and "*urophyllum*-group". The first is characterized by large and dull achenes, only partially covered by the perianth which is persistent, characterized by epidermic cells of type III (sensu Hong *et al.*, 1998) and with three main nervatures analogously to Persicarieae (Sun *et al.*, 2008); the second has shiny achenes of smaller dimension, completely covered by the perianth, which is persistent, characterized by epidermic cells of type I (sensu Hong *et al.*, 1998) and has only one main

nervature analogously to Polygoneae (Sun *et al.*, 2008). These two groups, clearly recognizable also in the present results, may be considered at the rank of section, analogously to what has been already proposed by Roberty & Vautier (1964).

Fagopyrum Mill. sect. ***Fagopyrum*** (4 spp.)
(clade IX a, bootstrap 100%)
≡ *Helxine* L.
≡ *Phegopyrum* Peterm.
T: *Fagopyrum esculentum* Moench, typ. cons. (≡ *Polygonum fagopyrum* L.)
= *Kunokale* Raf. [1837](“1836”)
T: *K. carneum* Raf., nom. illeg. (≡ *Polygonum emarginatum* Roth = *Fagopyrum esculentum* Moench)

Fagopyrum Mill. sect. ***Polygonopsis*** Roberty & Vautier (14 spp.)
(clade IX b, bootstrap 99%)
T: *F. gilesii* (Hemsl.) Hedberg

Also *F. suffruticosum* Schmidt, to date not considered in the phylogenetic studies may belong to this section.

Harpagocarpus Hutch. & Dandy (1 sp.)
T: *Harpagocarpus snowdenii* Hutch. & Dandy (≡ *Fagopyrum snowdenii* (Hutch. & Dandy) S.P.Hong; = *Fagopyrum ciliatum* Jacq.-Fél.)

A monotypic genus that, differently to the other species of *Fagopyrum* s.l., is distributed in eastern Africa. Based on the suggestions by Ronse Decraene & Akeroyd (1988) and the palynological studies by Hong (1988), Ronse Decraene & Smets (1991) and Hong *et al.* (1998) proposed not considering it valid and including it in *Fagopyrum*. Until further in depth studies are carried out the authors prefer to retain it at genus rank, also due to its different geographical distribution.

Pteroxygonum Dammer & Diels (1 sp.)
≡ *Fagopyrum* Mill. sect. *Pteroxygonum* (Dammer & Diels) Haraldson
T: *Pteroxygonum giraldii* Dammer & Diels (≡ *Fagopyrum giraldii* (Dammer & Diels) Haraldson)

Chinese monotypic genus, distinguished from *Fagopyrum* s.s. due to the winged achene with three sharp horns at the base and an elongated floral tube in the fruiting stage; furthermore it has a basal chromosome number x = 10 instead of x = 8. Haraldson (1978), Ronse Decraene & Akeroyd (1988) and Hong *et al.* (1998) do not consider these characters sufficient for segregating it from *Fagopyrum* and they distinguish it only at section level; nevertheless, on the basis of the studies by Sun *et al.* (2008) it is clearly distinct from *Fagopyrum* s.s. and therefore also in the present study it is retained at genus rank, analogously to the treatment in the ‘Flora of China’ (Li & Grabovskaya-Borodina, 2003).

Tribus **Rumiceae** Dumort.
Genera included: *Emex*, *Oxyria*, *Rheum*, *Rumex*.
(clades V + VI + VII + VIII)

The present results do not support (but also do not refute) the monophyly of this tribe; instead, according to the phylogenetic analyses by Kim *et al.* (2005) and the phylogram by Sanchez & Kron (2008) the Rumiceae result as being monophyletic. It should be considered that the main aim of this research was *Polygonum* s.l. (Polygoneae and Persicarieae) and that the genera belonging to other groups are

poorly represented. Only further analyses, focused on their species, may verify their homogeneity, to date well supported by the morphological characters.

Emex Campd. (2 spp.)
(clade VI)
T: *Emex spinosa* (L.) Campd., typ. cons.
Certainly a monophyletic genus, composed of very similar species sometimes considered as subspecies. According to Sanchez & Kron (2008) it may be included within *Rumex*.

Oxyria Hill (1-4 spp.)
(clade VII)
T: *Oxyria digyna* (L.) Hill
Certainly a monophyletic genus, composed of very similar species sometimes considered as subspecies.

Rheum L. (ca. 60 spp.)
(clade VIII, bootstrap 90%)
T: *Rheum rhaponticum* L.
A genus confirmed as monophyletic from recent studies based on plastidial sequences (Wang *et al.*, 2005).

Rumex L. (ca. 200 spp.)
(clade V, bootstrap 81%)
T: *Rumex patientia* L.
Although on the basis of the results by Navajas-Pérez *et al.* (2005) based on nuclear and plastidial sequences the genus *Rumex* appears monophyletic, according to Sanchez & Kron (2008) it may include *Emex*.

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Review of the malacological list proposed by F. Sordelli in 1896 for the middle Pleistocene Piànico-Sèllere Basin (Bergamo, N Italy)

Abstract – The list of the fossil molluscs of the Piànico-Sèllere lacustrine Basin proposed by Sordelli (1896) has never been reviewed through the years. In the light of the palaeontological studies made on the basin and of the retrieval of the original material in the Sordelli Collection (Museo di Storia Naturale di Milano), it is now possible to review the malacological list and to suggest a stratigraphical collocation of his samples in the upper levels of the lacustrine phase of the Basin (MLP-Unit), on the basis of the palaeoenvironment reconstruction suggested by the malacofauna.

Key-words: continental molluscs, Sordelli, Piànico-Sèllere Basin, Pleistocene, Lombardy.

Riassunto – Revisione dell'elenco malacologico proposto da F. Sordelli nel 1896 per il bacino medio pleistocenico di Piànico-Sèllere (Bergamo, Nord Italia).

L'elenco dei molluschi fossili del bacino lacustre di Piànico-Sèllere proposto da Sordelli (1896) non è stato mai revisionato attraverso gli anni. Alla luce di alcuni studi paleontologici compiuti sul bacino e del ritrovamento del materiale originale nella Collezione Sordelli (Museo di Storia Naturale di Milano), è stato ora possibile revisionare l'elenco malacologico e suggerire una collocazione stratigrafica dei suoi campioni nei livelli superiori della fase lacustre del bacino (Unità MLP), sulla base della ricostruzione paleoambientale suggerita dalla malacofauna.

Parole chiave: molluschi continentali, Sordelli, Bacino di Piànico-Sèllere, Pleistocene, Lombardia.

Introduction

The Piànico-Sèllere Basin is located in the Orobic Prealps (Bergamo, N Italy). It has recently been studied from many points of view (Moscariello *et al.*, 2000; Ravazzi, 2003; Ravazzi, 2006). In particular, new considerations have been made through the study of the malacological fossil record (Esu & Gianolla, in press): thanks to these multidisciplinary contributions the geological and palaeontological framework of the Basin is going to become increasingly clear.

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A middle Pleistocene succession of lacustrine sediments can be recognized in the Basin (Moscariello *et al.*, 2000; Ravazzi, 2006). The main feature of the Basin is the long deposition of a sequence of varves (Ravazzi, 2003; Mangili *et al.*, 2005), constituting the unit called BVC – "Banco Varvato Carbonatico" (Varvate Carbonatic Bed). Uppermost of the BVC a mainly turbiditic unit, with some thin varved layers, is present: the MLP – "Membro di La Palazzina" (La Palazzina Member; for the stratigraphy of the Basin see Moscariello *et al.*, 2000 and Ravazzi, 2006). The most famous fossil retrieval in the Basin is the fossil deer (Confortini *et al.*, 2003), recognized as *Cervus elaphus acoronatus* Beninde, which allowed to date the Basin at middle Pleistocene (Govoni *et al.*, 2006). In the Basin two tephra layers are also present, and this evidence allows to place the Basin in the middle Pleistocene (Pinti *et al.*, 2001; Brauer *et al.*, 2007a), even if there are some problems of interpretation (Pinti *et al.*, 2007; Brauer *et al.*, 2007b).

The recent results update the knowledge developed through about 150 years of studies. The studies on the Piànico-Sèllere Basin, actually began during the second half of the XIX Century with many published papers (*e.g.* Stoppani, 1857, 1873, 1880; Bassani, 1886; Corti, 1892; Baltzer, 1893). In one of the most complete studies of this period about the palaeontology of the Basin Sordelli (1896) described in detail the palaeobotanical record of the Lombardy region (N Italy) and the associated fossil fauna. He was one of the first to list the fossils of the Piànico-Sèllere Basin: he carefully described the fossil leaves present in the sediments and reported some information about the other fossils. In the present work, we focus our attention on the malacological list of the Piànico-Sèllere Basin as presented by the author as follows (Sordelli, 1896: 205):

«*Sphaerium* sp.? Una valva assai guasta che per la forma generale riterrei appartenente a questo genere, mentre per la regolarità e rilievo delle linee di accrescimento potrebbe forse essere diversa dalle specie indigene.

Unio longirostris Ziegl. – Identica per la forma alla descrizione che ne dà Rossmaessler. È una forma tutt'ora vivente della *U. pictorum* Linn.

Bythinia tentaculata (L.) ed opercoli della stessa specie.

Planorbis carinatus Müll.

Limnaea (sect. *Gulnaria*) cfr. *auricularia*.

Zonites sp. – Affine a *Z. verticillus* Fér. Non ho potuto stabilire la completa identità fra l'unico esemplare veduto e la specie vivente. Tuttavia rimane assodato come anche qui fosse rappresentato un genere di Gasteropodi terrestri ora affatto estraneo alla Lombardia, e proprio di paesi più orientali, avente la sua principale area di diffusione tra la Dalmazia e l'Asia minore.»

(«*Sphaerium* sp.? A very fail valve that, for the general shape, I would believe as belonging to this genus, while, for the regularity and the pronunciation of the growth lines, it could perhaps be different from the indigenous species.

Unio longirostris Ziegl. – Identical for shape to the description given by Rossmaessler. It is a still living form of the *U. pictorum* Linn.

Bythinia tentaculata (L.) and opercula of the same species.

Planorbis carinatus Müll.

Limnaea (sect. *Gulnaria*) cfr. *auricularia*.

Zonites sp. – Similar to *Z. verticillus* Fér. I was not able to establish the complete identity between the unique observed specimen and the living species. However it

remains undisputed that also a terrestrial gastropod genus, now totally stranger from Lombardy and typical of more eastern countries, with its main distribution area between Dalmatia and Asia Minor, were here represented.»)

Materials and methods

The material of the Sordelli Collection analyzed in the present work is kept in the Museo Civico di Storia Naturale di Milano. The Curator of the department of Invertebrate Palaeontology, G. Teruzzi, made the material available for study.

Not all the molluscs listed by Sordelli have been found in the Collection. The original description suggests that some whole shells were recovered and stored, whereas in the Sordelli's material only fragments of molluscs are visible in two little samples of sediment (Fig. 1). The catalogue numbers of the examined samples are MSNM B 3818 and MSNM B 3819. The stratigraphical context of the material is not reported by the author; just little information is reported in the original tag: «Farinose fossiliferous limestone. Interglacial. Piànico».

After the 1943 bombing, all the material stored in the Museo di Milano was sooted, therefore it became very difficult to study. An accurate cleaning with a dry paintbrush was necessary to analyse the material, but the procedure was not sufficient to remove the soot completely. For obvious reasons it was impossible to subject the material to a disaggregating treatment in H_2O_2.

Fig. 1 – The two malacological samples kept in the Sordelli Collection in the care of the Museo di Storia Naturale di Milano. Scale bar: 5 cm.

Fig. 1 – I due campioni malacologici custoditi nella Collezione Sordelli presso il Museo di Storia Naturale di Milano. Barra dimensionale: 5 cm.

An observation by a stereo-microscope allowed to recognize the species and to give them an environmental significance, using the ecological marks proposed by Ložek (1964). The ecological marks utilized in the present work are: 10F for the species living in current waters, 10S for the species living in stagnant waters, 10SF for the species living in stagnant or current waters, 10F(S) for the species prevalently living in current but also in stagnant waters, 10S(F) for the species prevalently living in stagnant but also in current waters, 1W!! for the species living in woods that are also typical of temperate periods.

The material was compared with that coming from the Main Section (in which BVC and MLP crop out, Moscariello *et al.*, 2000; Ravazzi, 2006), sampled by the writer, and from the Deer Section (the material is stored in the Museo Civico di Scienze Naturali "E. Caffi", Bergamo, and is referred to the excavations S1660 and S1679 of the Museum).

Results

Observing the samples of the Sordelli Collection, constituted by a whitish-yellowish, very farinose sediment, some laminated levels are visible on the side: they appear similar to varves but they are not so thin nor so clear like those present in the BVC unit (Fig. 2).

In the samples four taxa was recognized: the gastropods *Bithynia* cf. *B. tentaculata* (Linnaeus) and *Planorbis* cf. *P. carinatus* (Müller), the bivalves *Pisidium* sp. and *Unio* sp.

In the light of this recognized molluscs and of the molluscs recovered in four stratigraphical sections and a deep core of the Basin (Esu & Gianolla, in press), it is possible to review the malacological list proposed by Sordelli:

- «*Sphaerium* sp.?». In the samples of the Sordelli Collection no traces of the genus *Sphaerium* Scopoli were found: the unique small bivalve recovered in the samples was attributed to the genus *Pisidium* Pfeiffer for its shape and its dimensions (Fig. 3A). Up to now no remains attributable to *Sphaerium* were found in the Basin (in the samples from the sections or from the core), thus it is not yet possible to confirm its presence. However D. Esu (pers. comm.) signalled some bivalves
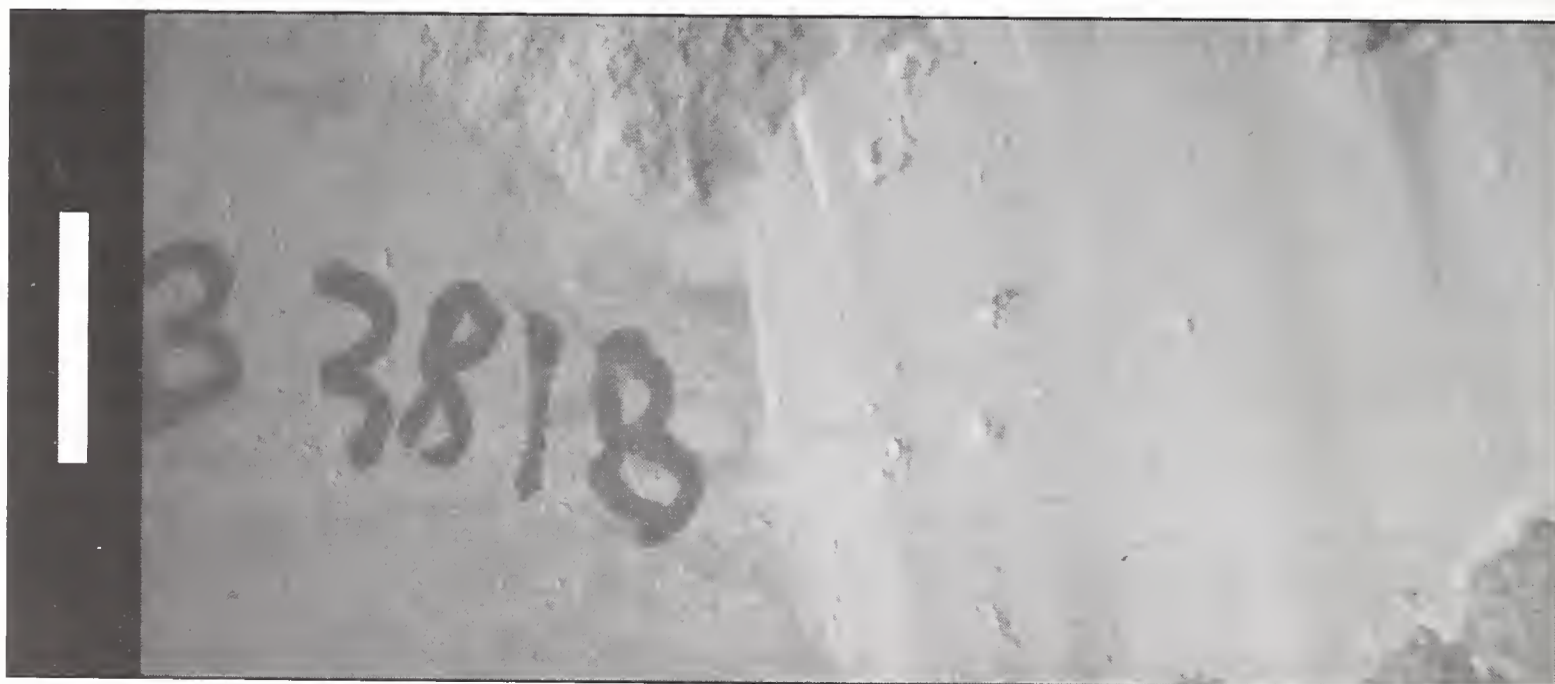
Fig. 2 – The board of the sample MSNM B 3818. Scale bar 1 cm.
Fig. 2 – Bordo del campione MSNM B 3818. Barra dimensionale 1 cm.

found out of a stratigraphical context which, for shape and dimensions (about 1 cm in length), can dubitatively be attributed to this genus (the material is not available). All the small bivalves recorded in the stratigraphical sections and in the core were attributed to the genus *Pisidium*: it is present in almost all the analyzed samples of the Basin (Esu & Gianolla, in press). The genus includes many species, representative of different environments, therefore it is not possible to assign an ecological mark to the whole genus. In the material sampled from the sections the following species were identified: *P. henslowanum* (Sheppard) (largely diffused in rivers, channels, streams and low altitude lakes (Castagnolo *et al.*, 1980); ecological mark: 10F(S)), *P.* cf. *milium* Held (in rivers, lakes, streams and channel, rarely in still waters (Castagnolo *et al.*, 1980); ecological mark: 10SF), *P.* cf. *nitidum* Jenyns (in rivers, streams, lakes and ponds (Castagnolo *et al.*, 1980); ecological mark: 10F(S)), *P.* cf. *subtruncatum* Malm (it prefers stream waters but it occurs also in still waters (Castagnolo *et al.*, 1980); ecological mark: 10SF), *P.* cf. *personatum* Malm (largely diffused in every freshwater environment (Castagnolo *et al.*, 1980); the species is not mentioned by Ložek (1964)).

- «*Unio longirostris* Ziegl.». The systematic of the genus *Unio* Retzius is complex and it underwent many revisions through the years (Zilch, 1967; Graf, 2007). *U. longirostris* Ziegler is a synonym of *U. rostratus* Lamarck (Graf & Cumings, 2007a), which can be included in the species *U. pictorum* (Linnaeus) (Graf, 2007). At present, just the species *U. elongatulus* Pfeiffer is signalled in Italy (Castagnolo *et al.*, 1980). The relationship between *U. pictorum* and *U. elongatulus* is not very clear (Araujo *et al.*, 2005) but following Modell (1964) both species belong to the same "*U. pictorum* group" and might represent a case of speciation in action (Badino *et al.*, 1991). Graf & Cumings (2007b) do not consider *U. elongatulus* in their checklist of the family Unionidae: more comparisons are now necessary to correctly locate the specimens found in the Piànico-Sèllere Basin. Just a little fragment attributable to *Unio* sp. was found in the samples of the Sordelli Collection (Fig. 3B), but the genus was found in many levels sampled in the other part of the Basin (Esu & Gianolla, in press): a whole valve (dubitatively attributable to *U.* cf. *elongatulus*) was found in the excavation S1679 by the staff of the Museum "E. Caffi" (Fig. 3G, the stratigraphy of the sample is not available). The species *U. elongatulus* is signalled in the freshwaters of the whole Mediterranean Basin (Castagnolo *et al.*, 1980); following Ložek (1964, in which the species *U. elongatulus* is not described) the genus *Unio* usually indicates current waters (*e.g. U. pictorum*: mark 10F).

- «*Bythinia tentaculata* (L.)» is a synonym of *Bithynia tentaculata* (Linnaeus). The presence is confirmed but a more prudent *B.* cf. *tentaculata* should be used because of the bad preservation of the material (Fig. 3C). The species (mark 10SF) characterizes environments of slow current or stagnant waters (Girod *et al.*, 1980). In the Basin, almost all remains of *Bithynia* are represented by opercula and this was interpreted as the clear evidence of a transport (Esu & Gianolla, in press).

- «*Planorbis carinatus* Müll.». The presence of the species *P. carinatus* (Müller) is confirmed. In the samples of the Sordelli Collection some badly preserved shells are present: the taxon *P.* cf. *carinatus* (Müller) is preferred for identification, because it is more appropriate (Fig. 3E, F). The species (mark 10S) lives in stagnant waters (Girod *et al.*, 1980). In the cropping out sections of the Basin some fragments or some whole shells included in the sediment were found (Gianolla, 2006; Esu & Gianolla, in press).
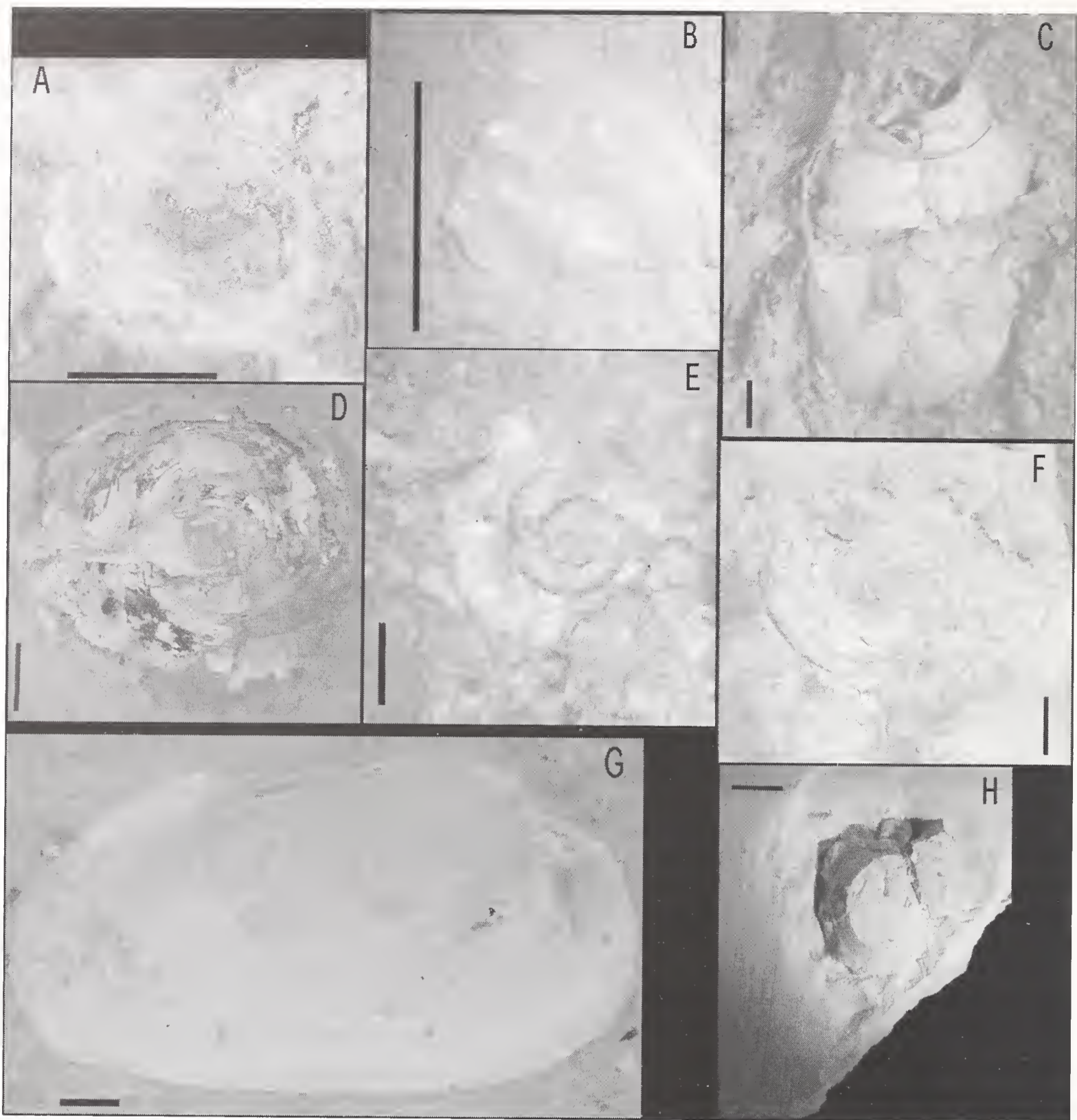
Fig. 3 – A) *Pisidim* sp. from sample MSNM B 3819 of the Sordelli Collection. Scale bar: 1 mm. B) Fragment of *Unio* sp. from sample MSNM B 3819 of the Sordelli Collection. Scale bar: 5 mm. C) *Bithynia* cf. *B. tentaculata* (Linnaeus) from sample MSNMB 3818 of the Sordelli Collection. Scale bar: 1 mm. D) Gastropoda indet. (terrestrial?) from excavation S1679 of the Museo Civico di Scienze Naturali "E. Caffi", Bergamo. Scale bar: 5 mm. E) *Planorbis* cf. *P. carinatus* Müller from sample MSNM B 3818 of the Sordelli Collection. Scale bar: 1 mm. F) *Planorbis* cf. *P. carinatus* Müller from sample MSNM B 3819 of the Sordelli Collection. Scale bar: 1 mm. G) *Unio* cf. *U. elongatulus* Pfeiffer from excavation S1679 of the Museo Civico di Scienze Naturali "E. Caffi", Bergamo. Scale bar: 5 mm. H) *Radix* cf. *R. auricularia* (Linnaeus) from excavation S1660 of the Museo Civico di Scienze Naturali "E. Caffi", Bergamo. Scale bar: 5 mm.

Fig. 3 – A) *Pisidim* sp. dal campione MSNM B 3819 della Collezione Sordelli. Barra dimensionale: 1 mm. B) Frammento di *Unio* sp. dal campione MSNM B 3819 della Collezione Sordelli. Barra dimensionale: 5 mm. C) *Bithynia* cf. *B. tentaculata* (Linnaeus) dal campione MSNM B 3818 della Collezione Sordelli. Barra dimensionale: 1 mm. D) Gastropoda indet. (terrestre?) dallo scavo S1679 del Museo Civico di Scienze Naturali "E. Caffi" di Bergamo. Barra dimensionale: 5 mm. E) *Planorbis* cf. *P. carinatus* Müller dal campione MSNM B 3818 della Collezione Sordelli. Barra dimensionale: 1 mm. F) *Planorbis* cf. *P. carinatus* Müller dal campione MSNM B 3819 della Collezione Sordelli. Barra dimensionale: 1 mm. G) *Unio* cf. *U. elongatulus* Pfeiffer dallo scavo S1679 del Museo Civico di Scienze Naturali "E. Caffi", Bergamo. Barra dimensionale: 5 mm. H) *Radix* cf. *R. auricularia* (Linnaeus) dallo scavo S1660 del Museo Civico di Scienze Naturali "E. Caffi", Bergamo. Barra dimensionale: 5 mm.

- «*Limnaea* (sect. *Gulnaria*) cfr. *auricularia*» is a synonym of *Radix auricularia* (Linnaeus). It is not present in the samples of the Sordelli Collection. A specimen attributable to *R.* cf. *auricularia* was found in the upper part of MLP, in the levels containing the fossil deer (Fig. 3H). Moreover in the Piànico Basin the genus *Radix* Montfort is represented by some small apexes assigned to the taxon *R.* cf. *peregra* (Müller): however the morphology of the two species is not easily recognizable (Girod *et al.*, 1980), thus it is not possible to definitively distinguish the two species without the entire shell. The species *R. auricularia* (mark 10S) lives in the stagnant waters (Girod *et al.*, 1980), while *R. peregra* (mark 10S(F)) can also live in waters with a slow current (Girod *et al.*, 1980).

- «*Zonites* sp. – Similar to *Z. verticillus* Fér.». *Zonites verticillus* Férrussac is a synonym of *Aegopis verticillus* (Férussac). It seems to be the only terrestrial record found in the whole Basin. It is not present in the samples of the Sordelli Collection nor in the material sampled in the cropping out sections of the Basin, so its presence cannot be confirmed. A possible terrestrial mollusc was recovered in the damming S1679 of the Museum "E. Caffi": it is not recognizable but its dimensions are compatible with those of *A. verticillus* (Fig. 3D, the stratigraphical context of the sample is not available). The ecological mark of the species is 1W!!: it indicates a wood environment in a temperate period. Following Girod (1973), the species is known in Lombardy for the Riss-Würm interval in the Zandobbio's breccia (Bergamo). Since the retrieval was not confirmed for the Piànico-Sèllere Basin, it is not possible to consider its ecological mark for the environmental reconstruction, however the presence of a whole shell of a terrestrial mollusc could indicate an environment of shallow, undisturbed waters.

Discussion

The malacofauna recovered in the samples of the Sordelli Collection (in particular the presence of shells attributable to the genus *Planorbis*), also considering the kind of the sediment, suggests a stagnant, shallow waters environment. Some clearly transported elements (*e.g.* the fragments of *Unio* sp.) suggest the presence of a contribution of a small water course. The deposit with the described malacofauna could have been accumulated in a margin context, particularly if the presence of terrestrial molluscs will be confirmed.

The temperate genus *Tanousia* Servain (extinct in Italy), characterizing the all BVC and the lower part of MLP (Esu & Gianolla, 2008), is completely absent both in the list proposed by Sordelli and in his samples: it appears unlikely that the material was sampled in the BVC unit or in the lower part of MLP, it appears more probable that it was sampled from the upper part of MLP, in correspondence of a climatic worsening (Esu & Gianolla, in press).

The Molluscan fauna of the samples of the Sordelli Collection appears comparable to the assemblages present in the levels of the upper part of MLP (see Gianolla, 2006 and Esu & Gianolla, in press) containing the fossil deer (Confortini *et al.*, 2003; Govoni *et al.*, 2006). Here a shallow water context is represented, with evidence of a slow transport and a build-up of molluscs: this was interpreted as a margin context. The genera *Planorbis*, *Bithynia*, *Unio* and *Pisidium* were recognized also in the deer levels (while *Tanousia* is absent) and their preservation state

is similar to the preservation state of the material recorded in the samples of the Sordelli Collection.

In conclusion, it is possible to suggest a correspondence between the two environmental contexts on the basis of the described similarities.

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Antonio De Angeli*, Alessandro Garassino** & Giovanni Pasini***

New reports of anomurans and brachyurans from the Cenozoic of Tuscany (Italy)

Abstract – Anomurans and brachyurans from Tuscany have previously been reported by Cappellini (1874), Fucini (1910), Ristori (1886, 1888, 1891, 1892, 1896), Vinassa de Regny (1897), and Delle Cave (1988a, b). The recent discovery of new anomurans and brachyurans from some localities in Pisa, Livorno, Siena, and Grosseto provinces increases the carcinologic knowledge from the Cenozoic of Italy. The infraorder Anomura H. Milne Edwards, 1832, includes *Callianassa* cfr. *C. subterranea* (Montagu, 1808) and *C. chalmasii* Brocchi, 1882 (Callianassidae Dana, 1852); *Dardanus substriatus* (A. Milne Edwards, 1861) (Diogenidae Ortmann, 1892). The infraorder Brachyura Latreille, 1802, includes *Lysirude paronae* (Crema, 1895) and *Raninoides pliocenicus* n. sp. (Raninidae De Haan, 1839); *Medorippe ampla* Garassino, De Angeli, Gallo & Pasini, 2004 (Dorippidae MacLeay, 1838); *Ethusa popognensis* n. sp. (Ethusidae Guinot, 1977); *Calappa granulata* (Linnaeus, 1758) (Calappidae H. Milne Edwards, 1837); *Ebalia* cfr. *E. deshayesi* Lucas, 1846, *E. cranchii* Leach, 1817, *E. fucinii* Ristori, 1892, *Ilia pliocenica* Ristori, 1891, and *Palaeomyra bispinosa* A. Milne Edwards, 1861 (Leucosiidae Samouelle, 1819); *Liocarcinus* sp. (Portunidae Rafinesque, 1815); *Monodaeus bortolottii* Delle Cave, 1988 (Xanthidae MacLeay, 1838); *Pilumnus ristorii* new replacement name for *P. spinosus* Ristori, 1886 (Pilumnidae Samouelle, 1819); *Eriphia cocchii* Ristori, 1886 (Eriphiidae MacLeay, 1838); *Goneplax gulderi* Bachmayer, 1953 (Goneplacidae MacLeay, 1838); *Astenognathus* sp. (Varunidae H. Milne Edwards, 1853). The discovery of *Raninoides* H. Milne Edwards, 1837, is very important because it represents the first report of this genus in the Pliocene of Europe.

Key words: Crustacea, Decapoda, Cenozoic, Tuscany, Italy.

Riassunto – Nuova segnalazione di anomuri e brachiuri nel Cenozoico della Toscana (Italia).
Gli anomuri e i brachiuri della Toscana sono stati precedentemente segnalati da Cappellini (1874), Fucini (1910), Ristori (1886, 1888, 1891, 1892, 1896), Vinassa de Regny (1897) e Delle Cave (1988a, b). La recente scoperta di nuovi anomuri e brachiuri in alcune località delle province di Pisa, Livorno, Siena e Grosseto incrementa le conoscenze carcinologiche per il Cenozoico d'Italia. L'infraordine Anomura H. Milne Edwards, 1832 comprende *Callianassa* cfr. *C. subterranea* (Montagu, 1808) e *C. chalmasii* Brocchi, 1882 (Callianassidae Dana, 1852); *Dardanus substriatus* (A. Milne Edwards, 1861) (Diogenidae Ortmann, 1892). L'infraordine Brachyura Latreille, 1802 comprende *Lysirude paronae* (Crema, 1895) e *Raninoides pliocenicus* n. sp. (Raninidae De Haan, 1839); *Medorippe ampla*

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Garassino, De Angeli, Gallo & Pasini, 2004 (Dorippidae MacLeay, 1838); *Ethusa popognensis* n. sp. (Ethusidae Guinot, 1977); *Calappa granulata* (Linnaeus, 1758) (Calappidae H. Milne Edwards, 1837); *Ebalia* cfr. *E. deshayesi* Lucas, 1846, *E. cranchii* Leach, 1817, *E. fucinii* Ristori, 1892, *Ilia pliocenica* Ristori, 1891 e *Palaeomyra bispinosa* A. Milne Edwards, 1861 (Leucosiidae Samouelle, 1819); *Liocarcinus* sp. (Portunidae Rafinesque, 1815); *Monodaeus bortolottii* Delle Cave, 1988 (Xanthidae MacLeay, 1838); *Pilumnus ristorii* nuovo nome per *P. spinosus* Ristori, 1886 (Pilumnidae Samouelle, 1819); *Eriphia cocchii* Ristori, 1886 (Eriphiidae MacLeay, 1838); *Goneplax gulderi* Bachmayer, 1953 (Goneplacidae MacLeay, 1838); *Asthenognathus* sp. (Varunidae H. Milne Edwards, 1853). La scoperta di *Raninoides* H. Milne Edwards, 1837 è molto importante in quanto rappresenta la prima segnalazione di questo genere nel Pliocene europeo.

Parole chiave: Crustacea, Decapoda, Cenozoico, Toscana, Italia.

Introduction and geological setting

The anomurans and brachyurans from the Cenozoic of Tuscany have been the subject of study by Cappellini (1874), Fucini (1910), Ristori (1886, 1888, 1891, 1892, 1896), Vinassa de Regny (1897), and Delle Cave (1988a, b) who reported the presence of these decapods from Firenze, Pisa, Livorno, and Siena provinces (see Garassino & De Angeli, 2004; De Angeli & Garassino, 2006a and Appendix).

The recent discovery of anomurans and brachyurans from some new localities or previously reported localities with incorrect or generalised place-names, such as Parrana San Giusto, Rio Popogna (Livorno), Presciano (Siena), Monterotondo Marittimo (Grosseto) and from some already known localities, such as Balconevisi (Pisa), Pietrafitta, Ciuciano, La Strolla, Poggio alla Staffa, Cava I Sodi, and Terre Rosse (Siena), (Fig. 1), allowed to increase the carcinologic knowledge about these groups during the Mio-Pliocene and Lower Pleistocene evolution of the Tuscany basin (Bossio *et al.*, 1993).
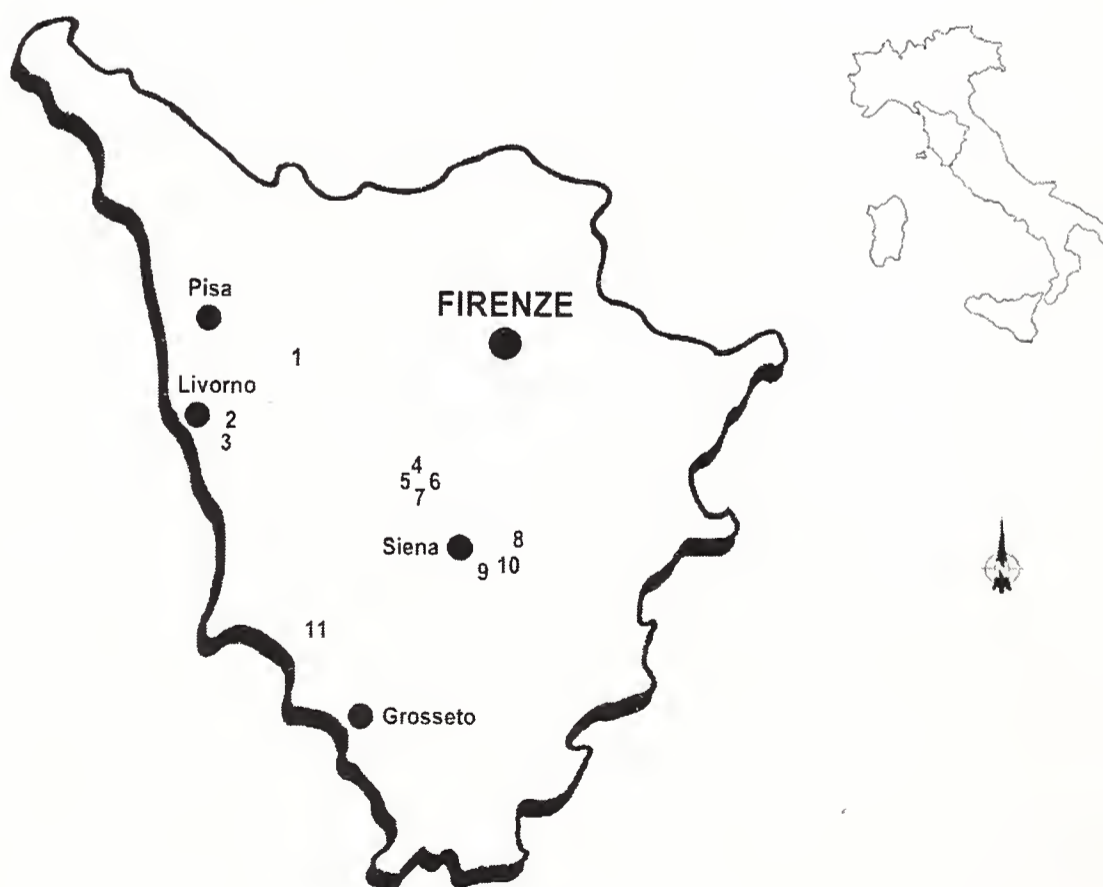
Fig. 1 – Tuscany Region with the new fossiliferous localities. / Regione Toscana con le nuove località fossilifere. 1) Balconevisi. 2) Parrana San Giusto. 3) Rio Popogna. 4) Pietrafitta. 5) Ciuciano. 6) La Strolla. 7) Poggio alla Staffa. 8) Presciano. 9) Cava I Sodi. 10) Terre Rosse. 11) Monterotondo Marittimo.

Balconevisi

The small village of Balconevisi is located on the top of a hill, 6 km S of San Miniato municipality (Pisa), on the left flank of the southern Val d'Elsa River Basin (Parona, 1903). The studied specimens (MSNM i27214, GPDG 0065) were discovered in bluish clays from the Lower Pliocene (Piacentian) (Dominici *et al.*, 1997; Carta Geol. Toscana 1:250.000, UniSiena 2004).

Parrana San Giusto

Parrana San Giusto (Livorno) is located about 4 km N of Gabbro village, in the Livornesi Mounts. The studied specimens (GPDG 0076, 0089) were discovered in sandy deposits (grey sands). These sediments are dated as Pliocene (Carta Geol. Toscana, foglio 284, Rosignano Marittimo; 1:25.000), but also, in the upper part, as Pleistocene for the malacofauna (Forli, pers. comm., 2008). The studied specimens, without relaiable stratigraphic data, have been ascribed generically to the Plio-Pleistocene (Bossio *et al.*, 1981; Cauli, 1981).

Rio Popogna

Rio Popogna, located W of Gabbro village (Livorno), close to Livornesi Mounts (De Stefani, 1911), exposes, along its upper course, a limited and discontinuous series of fossiliferous marine deposits (30 m long) of marly clays from the Tortonian (Miocene) (Parona, 1903) and sandy clays from the lower Messinian (Miocene) (Trentanove, 1901; Carta Geol. Toscana, foglio 284, Rosignano Marittimo; 1:25.000). The studied specimens (GPDG 0051-0061, 0070-0072, 0085-0087; MSNM i27082-i27087) come from small sized blocks of eroded sediment, enclosing a rich and well diversified carcinologic fauna, strongly compressed irregular echinoids (spatangids), gastropods, bivalves and rare fragments of terrestrial plants. The crustaceans are usually disarticulated, testifying to transport *post mortem* and they are distributed in different clay-marly levels of the exposed series, 1.70 m thick.

Pietrafitta

This locality, known for the rich malacofauna, is located behind San Gimignano and Poggibonsi municipality (Siena), including two localities, close to each other, called "Vigna" and "Villa". The studied specimens (GPDG 0077, 0078, 0082, 0083; MSNM i27215) were collected in yellow sands from the Lower Pliocene (Pantanelli, 1880; Carta Geol. Toscana, 1:10.000).

Ciuciano

The studied specimens (GPDG 0079, 0080) were discovered in this locality, located in San Gimignano municipality (Siena), and known for its sands and grey clays, rich in marine invertebrates from the Lower Pliocene (Zanclean – Piacentian) (Forli & Dell'Angelo, 2000).

La Strolla

A wide quarry, La Strolla, located about 4 km S of Poggibonsi (Siena) (Carta Geol. Toscana, foglio 286, Poggibonsi; 1:100.000), is known for the richness and variety of its fossils (Fioravanti *et al.*, 2000). The basal deposits are composed of gravels and sands from the lower Messinian (Miocene), covered by green clays from the upper Messinian. Gray clays from the Lower Pliocene and sands from the

Middle-Upper Pliocene are present at the top of the series (Brunetti, 2002). The studied specimen (GPDG 0081), without stratigraphic reference, comes from the upper sandy levels, dated as Pliocene *sensu lato*.

Poggio alla Staffa

The studied specimen (GPDG 0075) was discovered in the locality Podere Melograni-Poggio alla Staffa, close to Colle Val d'Elsa (Siena) where marine sands and grey clays of littoral environment from the Lower Pliocene (Piacentian - Zanclean) crop out (Brunetti & Della Bella, 2003; Carta Geologica Toscana, 1:10.000).

Presciano

The studied specimen (GPDG 0073) was discovered close to Taverne d'Arbia village, at Presciano, located E of Siena. The sedimentary series includes yellow sandy facies from the Lower-Middle Pliocene (Carta Geol. d'Italia, IGM, foglio 121, Montepulciano; 1:100000, Ist. Poligrafico di Stato, Ercolano, NA, 1960). Therefore, the specimen has been ascribed generically to the Pliocene.

Cava I Sodi

The studied specimen (GPDG 0066) was discovered in a quarry, close to Castelnuovo Berardenga-Scalo, located E of Siena. This quarry shows deposits of clays and sandy clays from the Lower-Middle Pliocene (Carta Geol. d'Italia, IGM, foglio 121, Montepulciano; 1:100000, Ist. Poligrafico di Stato, Ercolano, NA, 1960), already known for the rich malacofauna and fossil vertebrates (Bogi *et al.*, 2002; Manganelli & Spadini, 2001, 2003). We ascribed the specimen generically to the Pliocene *sensu lato* because of the absence of chronostratigraphic data.

Terre Rosse

The studied specimens (GPDG 0062-0064, 0069, 0074, 0084) were discovered in Terre Rosse, N of Rapolano Terme (Siena), that includes two localities close to each other (Stroncoli e Campino) where sands of littoral origin from the Lower Pliocene (Piacentian) preserve marine vertebrates and invertebrates (Laghi, 1984; Manganelli *et al.*, 2003; Forli *et al.*, 2004) (Carta IGM, 1:25.000, Foglio 297, sez. I, 1994).

Monterotondo Marittimo

Monterotondo Marittimo is located in Grosseto province close to the Metalliferi Mounts. The sediments of a small abandoned quarry, located SW of Monterotondo Marittimo, undergo a washing away, producing the exposure of the studied specimens (GPDG 0067, 0068, 0088; CF-TCR 1, 2; IGF 13314E, 14636E, 14637E). Moreover, fragments of a juvenile misticete were discovered in this quarry (Casati, pers. comm., 2007). The studied specimens, discovered in grey poorly fossiliferous clays, are usually associated with rare small-sized bivalves and irregular echinoids, that are strongly compressed (*Schizaster*? Pasini, pers. comm., 2007). Indeterminate bits of organic materials are also present. The kind of deposition and its discontinuity could indicate an environment of chaotic sedimentation in the presence of more or less wide submarine conoids. The marly marine deposits of the studied area are dated to the Lower-Middle Pliocene (Carta Geol. d'Italia., foglio 119, Massa Marittima, 1:100000). We ascribed the studied specimens to the Pliocene *sensu lato* because of the absence of chronostratigraphic data (Bisconti, pers. comm., 2007).

Material

The studied sample includes 51 specimens of anomurans and brachyurans. We identified some specimens as belonging to species already known in Italy, and others as belonging to new species. Almost all specimens are preserved three-dimensionally and their preparation was easy as a result of the softness of surrounding clays and sands. Some specimens come from washing and sieving of sediments.

The infraorder Anomura H. Milne Edwards, 1832, includes *Callianassa* cfr. *C. subterranea* (Montagu, 1808) (11 specimens), *C. chalmasii* Brocchi, 1882 (2 specimens) and *Dardanus substriatus* (A. Milne Edwards, 1861) (2 specimens).

The infraorder Brachyura Latreille, 1802, includes *Lysirude paronae* (Crema, 1895) (1 specimen), *Raninoides pliocenicus* n. sp. (4 specimens), *Medorippe ampla* Garassino, De Angeli, Gallo & Pasini, 2004 (2 specimens), *Ethusa popognensis* n. sp. (1 specimen), *Calappa granulata* (Linnaeus, 1758) (2 specimens), *Ebalia* cfr. *E. deshayesi* Lucas, 1846 (1 specimen), *E. cranchii* Leach, 1817 (1 specimen), *E. fucinii* Ristori, 1892 (1 specimen), *Pilumnus ristorii* new replacement name for *P. spinosus* Ristori, 1886 (1 specimen), *Monodaeus bortolottii* Delle Cave, 1988 (1 specimen), *Ilia pliocenica* Ristori, 1891 (4 specimens), *Palaeomyra bispinosa* A. Milne Edwards, 1861 (1 specimen), *Liocarcinus* sp. (2 specimens), *Eriphia cocchii* Ristori, 1886 (3 specimens), *Goneplax gulderi* Bachmayer, 1953 (11 specimens), *Astenognathus* sp. (1 specimen).

The studied sample is housed in the Palaeontological Collections of the Museo Gruppo Paleontologico “C. De Giuli”, (Castelfiorentino - Firenze), housed in the Biblioteca Comunale Vallesiana (GPDG), Centro Civico “Ofelia Mangini”, seat of Gruppo GAMPS (Badia a Settimo, Scandicci – Firenze) (CF-TCR), Museo di Storia Naturale dell’Università degli Studi di Firenze (IGF), and in the Museo di Storia Naturale di Milano (MSNM). Some incomplete specimens, ascribed tentatively to *Raninoides* sp. are housed in the Università di Firenze (Casati, pers. comm., 2007).

The sizes of the specimens are expressed in millimetres.

The systematic arrangement used in this paper follows the recent classification proposed by Martin & Davis (2001) and Ng *et al.* (2008).

Abbreviations

lcxp = lenght of carapace
wcxp = width of carapace
wf = width of front
wo-f = width of orbito-frontal margin
lp = length of palm (excluded fixed finger)
h = height of palm
tp = thickness of palm
lt = length of propodus (with fixed finger)
lff = lenght of fixed finger
lmf = lenght of movable finger

Systematic Palaeontology

Infraorder Thalassinidea Latreille, 1831
Superfamily Callianassoidea Dana, 1852
Family Callianassidae Dana, 1852
Genus *Callianassa* Leach, 1814

Type species: *Cancer* (*Astacus*) *subterraneus* Montagu, 1808.

Callianassa cfr. *C. subterranea* (Montagu, 1808)
Fig. 2 A-B

Stratigraphic range: Upper Miocene (Messinian).
Type locality: Rio Popogna (Livorno).
Material and measurements: six left propodi (GPDG 0051, 0052, 0056, 0058, 0059, 0060) and five right propodi (GPDG 0053, 0054, 0055, 0057, 0061); two specimens (GPDG 0051, 0052) with propodus and merus.
GPDG 0051 – lt: --; lp: 7.8; h: 7.6
GPDG 0052 – lt: 14.6; lp: 7.7; h: 8.3
GPDG 0053 – lt: 7; lp: 4; h: 4
GPDG 0054 – lt: 8; lp: 4.5; h: 4.7
GPDG 0055 – lt: 13.3; lp: 6,5; h: 6.7
GPDG 0056 – lt: 8.7; lp: 5.1; h: 5
GPDG 0057 – lt: 142.2; lp: 5.9; h: 6.5
GPDG 0058 – lt: 9; lp: 5.3; h: 5
GPDG 0059 – lt: 7.7; lp: 4.6; h: 4.8
GPDG 0060 – lt: 13.3; lp: 7.8; h: 7
GPDG 0061 – lt: 8.4; lp: 4.8; h: 4.8
Description. Merus as long as high, with straight upper margin and convex lower margin. Propodus with palm longer than high. Upper and lower margins almost straight and divergent. Lower margin with dentate ridge. Outer surface slightly raised and smooth. Elongate fixed finger, strongly narrow and curved distally. Occlusal margin smooth and without teeth. Outer surface with longitudinal ridge and some orifices. Movable finger longer than fixed finger. Upper margin almost straight and convex only distally.
Discussion. The studied specimens have close morphological affinities with the Recent *Callianassa subterranea* (Montagu, 1808), widespread in the Eastern Atlantic Ocean and in the Mediterranean Sea with smaller specimens living in deeper waters (35-500 m) (Ngoc-Ho, 2003). This species has been also described in the fossil record from the Helvetian (Middle Miocene) of Albugnano (Piemonte) and from the Miocene of Sardegna (Crema, 1895; Lőrenthey, 1909). Moreover Ristori (1889) recorded *Callianassa subterranea* var. *dentata* from the Miocene-Pleistocene of Piemonte, Lazio, Puglia, and Sicilia. The studied specimens show, respect *C. subterranea*, margins of palm more inclined, fixed finger thinner and curved proximally, and movable finger more rectilinear.

Callianassa chalmasii Brocchi, 1883
Fig. 2 C-D

1883 – *Callianassa chalmasii* Brocchi; p. 6, 7, Pl. 5 (figs. 7, 8)
1898 – *Callianassa chalmasii* Brocchi *in* Lőrenthey; p. 93, 105, 114
1929 – *Callianassa chalmasii* Brocchi *in* Lőrenthey & Beurlen; p. 33, 65, Pl. 2 (figs. 15 a, b)
1961 – *Callianassa espichelensis* Veiga Ferreira; p. 478, Pl. 1 (figs. 1-11)
1979 – *Callianassa chalmasii* Brocchi *in* Müller; p. 274, Pl. 1 (fig. 5)
1984 – *Callianassa chalmasii* Brocchi *in* Müller; p. 50, Pl. 2 (figs. 3-7)

Stratigraphic range: Lower Pliocene (Piacentian).
Type locality: Terre Rosse (Siena).
Material and measurements: two propodi, one right and one left.
GPDG 0062 – lt: 15; lp: 12.2; h: 11.5; tp: 4.7
GPDG 0063 – preserved palm, not measurable
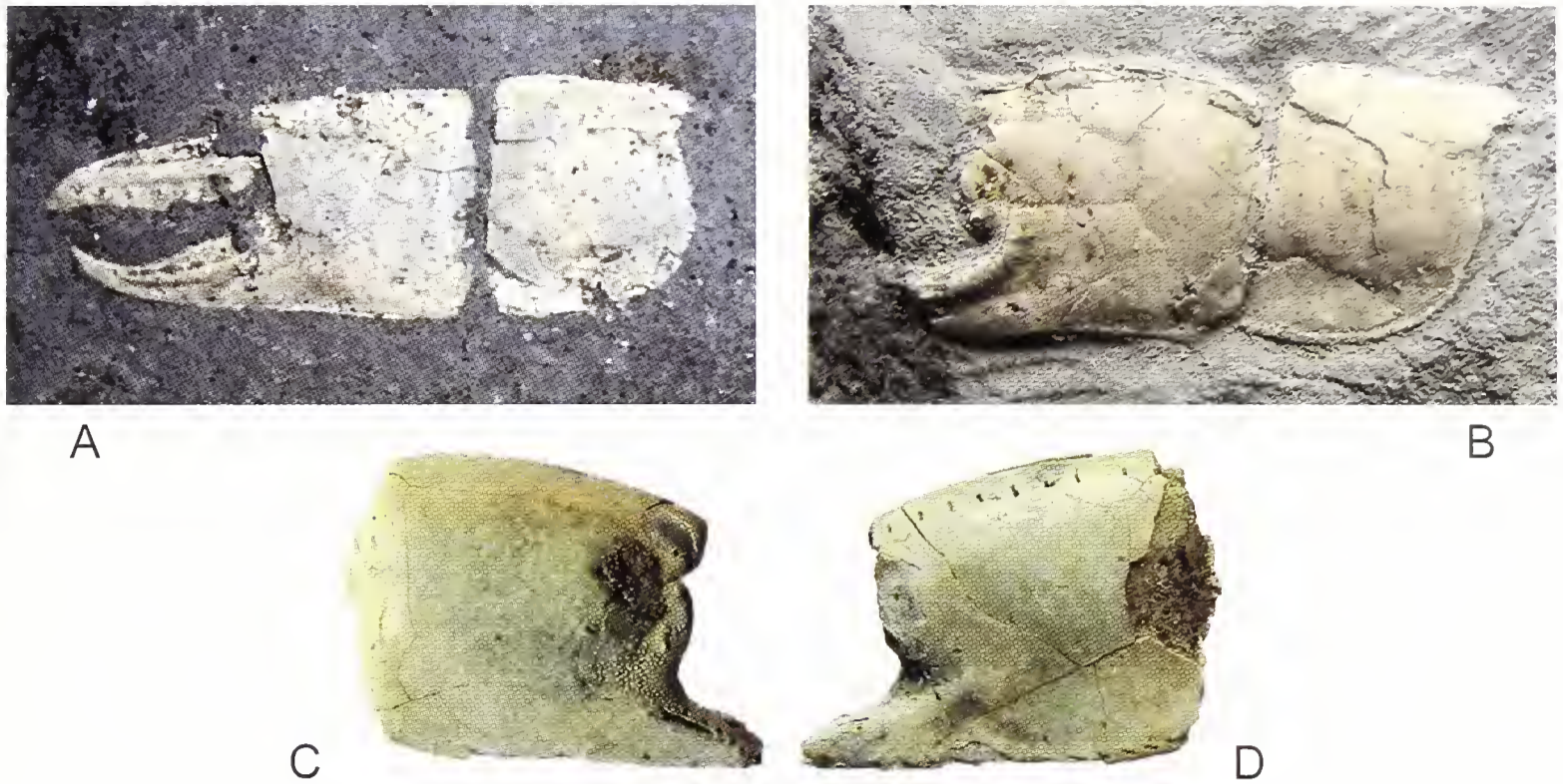
Fig. 2 – A) *Callianassa* cfr. *subterranea* (Montagu, 1808), GPDG0052, left cheliped/chelipede sinistro (x 2.2); B) *Callianassa* cfr. *subterranea* (Montagu, 1808), GPDG0051, left cheliped/chelipede sinistro (x 2.8). C, D) *Callinassa chalmasii* (Brocchi, 1883), GPDG0062, right propod/propodus destro. C) outer view/norma esterna. D) inner view/norma interna (x 1.5).

Discussion. The studied specimens have a short carpus, raised on outer surface and with lower margin strongly convex. Subsquare palm, as long as high. Upper margin slightly convex, lower margin straight and ridged externally. Outer surface convex and smooth. Small granulations are located in the median part of palm, close to the fixed finger. Inner surface almost flat. Nine oval pits are present in the upper part, some orifices are present in the lower part, along the margin. Fixed figer poorly developed with one tooth on occlusal margin.

The studied propodi show morphological affinities with *Callianassa chalmasii* Brocchi, 1883, described from the Miocene (middle Badenian) of Hungary and recorded also from the Miocene (Tortonian) of Portugal (Veiga Ferreira, 1961; Müller, 1984a). Peculiar characters are the presence of one short fixed finger with one tooth on occlusal margin and aligned pits located on the upper part of inner surface of palm. Therefore the studied specimens represent a probable spread of this species also in the Pliocene.

Superfamily Paguroidea Latreille, 1802
Family Diogenidae Ortmann, 1892
Genus *Dardanus* Paulson, 1875

Type species: *Dardanus hellerii* Paulson, 1875.

Dardanus substriatus (A. Milne Edwards, 1861)
Fig. 3 A-B

1846 – *Pagurus striatus* Latreille *in* E. Sismonda; p. 70, Pl. 3 (fig. 8)
1861 – *Pagurus substriatus* A. Milne Edwards *in* E. Sismonda; p. 20
1886 – *Pagurus substriatus* A. Milne Edwards *in* Ristori; p. 124, Pl. 3 (figs. 14, 15)
1929 – *Pagurus substriatus* A. Milne Edwards *in* Glaessner; p. 288
2006 – *Pagurus substriatus* A. Milne Edwards *in* De Angeli & Garassino, p. 27

Stratigraphic range: Lower Pliocene (Piacentian).
Type locality: Terre Rosse (Siena) and Balconevisi (San Miniato – Pisa).
Material and measurements: one movable finger of left cheliped (GPDG 0064 from Terre Rosse: lmf: 14) and one right palm (GPDG 0065 from Balconevisi: lp: 14.6; h: 13.5; tp: 9.7).

Discussion. Palm longer than high, with upper and lower margins convex. Outer surface raised and totally covered with granulate transverse and sinuous ridges having many pores. Inner surface slightly convex with the same ornamentation of the outer surface. Fixed finger, incomplete distally, short and with two rows of tubercles separated by a smooth line. Movable finger having scaly sinuous course. The ridge is serrate because of the presence of small tubercles having apices with a small orifice. This species has been recorded by A. Milne Edwards (1861), E. Sismonda (1846, 1861), and Ristori (1886) from the Pliocene of Asti (Piemonte) and Volterra (Toscana). A. Milne Edwards (1861) compared *Pagurus substriatus* with the Recent *P. striatus* Latreille, 1803. *Pagurus striatus* is considered as synonymous of *Dardanus arrosor* (Herbst, 1796). Therefore the species described by A. Milne Edwards must be ascribed to *Dardanus* Paulson, 1875.

Fig. 3 – *Dardanus substriatus* (A. Milne Edwards, 1861), GPDG 0065, right propod/propodus destro. A) outer view/norma esterna. B) inner view/norma interna (x 1.5).

Infraorder Brachyura Linnaeus, 1758
Section Podotremata Guinot, 1977
Subsection Archaeobrachyura Guinot, 1977
Superfamily Raninoidea De Haan, 1839
Family Raninidae De Haan, 1839
Genus *Lysirude* Goeke, 1985

Type species: *Raninoides nitidus* A. Milne Edwards, 1880.

Lysirude paronae (Crema, 1895)
Fig. 4

1895 – *Lyreidus paronae* Crema; p. 671, Text-fig. 11
1907 – *Lyreidus paronae* Crema *in* Sacco ; p. 116
1929 – *Lyreidus paronae* Crema *in* Glaessner; p. 241
1998 – *Lysirude paronae* (Crema) *in* Tucker; p. 324
2004 – *Lysirude paronae* (Crema) *in* Garassino, De Angeli, Gallo & Pasini; p. 258, Text-figs. 3-4
2006 – *Lysirude paronae* (Crema) *in* De Angeli & Garassino; p. 36

Stratigraphic range: Pliocene *sensu lato*.
Type locality: Cava I Sodi, Castelnuovo Berardenga-Scalo (Siena).
Material and measurements: one complete specimen.

GPDG 0066 – lcxp: 23.7; wcxp: 15.8; wo-f: 6.8.

Discussion. The studied specimen has the narrow orbito-frontal margin with one strong extraorbital spine on both margins of rostrum and the presence of one spine on both anterolateral margins. These characters allow assignment of the studied specimen to *Lysirude paronae* (Crema, 1895) from the Helvetian (Miocene) of Sciolze and from the Langhian (Miocene) of S. Margherita (Torino). This species has been recently described also from the Pliocene of Orta San Giulio (Novara, Piemonte) (Garassino *et al.*, 2004).

Fig. 4 – *Lysirude paronae* (Crema, 1895), GPDG 0066 (x 2.5).

Genus *Raninoides* H. Milne Edwards, 1837

Type species: *Ranina laevis* Latreille, 1825.

Raninoides pliocenicus n. sp.
Fig. 5 A-D

Diagnosis: carapace convex transversely, longer than wide; triangular rostrum; supraorbital margins with three teeth and two fissures; anterolateral margins convex with one spine; dorsal regions not distinct; anterior part of the dorsal surface with one granulate postfrontal ridge; dorsal surface slightly dotted.

Etymology: the trivial name alludes to the Pliocene, geological age of the studied specimens.

Holotype: GPDG 0068.

Paratypes: GPDG 0067, CF-TCR1.

Stratigraphic range: Pliocene *sensu lato*.

Type locality: Monterotondo Marittimo (Grosseto).

Material and measurements: four complete specimens in dorsal view, from 15 to 30 mm long. GPDG 0067, 0068, CF-TCR 1, IGF 13314E (counter-part).

GPDG 0067 – lcxp: 23.3; wcxp: 13.4; wo-f: 10.4
GPDG 0068 – lcxp: 14.5; wcxp: 9; wo-f: 6.5
CF-TCR1 – lcxp: 28.4; wcxp: 17.2; wo-f: 12
IGF 13314E – lcxp: 15; wcxp: 9; wo-f: 7

Description: carapace convex transversely, longer than wide (width 0.60 maximum length of carapace, rostrum included). Orbito-frontal margin occupies the entire anterior part of carapace (orbito-frontal margin about 0.74 of the maximum width of carapace). Rostrum elongate, subtriangular with rounded tip. Short preorbital tooth. Wide supraorbital margin marked by two deep oblique fissures. Supraorbital tooth narrower, but longer than preorbital and extraorbital teeth. Supraorbital tooth with triangular tip. Extraorbital tooth wider than previous elongated forwards with one spine. Diverging antero-lateral margins with one oblique spine. Converging postero-lateral margins with one granulate ridge. Posterior margin narrower than orbito-frontal margin and slightly convex. Dorsal regions not distinct. One granulate post-frontal ridge, convex anteriorly, is located among antero-lateral spines. Dorsal surface with irregular pits.

Discussion. The morphological characters, peculiar of the species belonging to *Raninoides* H. Milne Edwards, 1837, and *Laeviranina* Lőrenthey & Beurlen, 1929, are very similar, making difficult their true systematic validity. In fact Feldmann (1991), Tucker (1998), and Schweitzer *et al.* (2000) have discussed their validity and recently Schweitzer *et al.* (2006) considered *Laeviranina* as synonymous of *Raninoides*. Schweitzer *et al.* (2006) also provided the check list of the fossil and Recent species known to date.

Twelve fossil species are known from America: *R. eugenensis* Rathbun, 1926 (Oligocene – Oregon), *R. fulgidus* Rathbun, 1926 (Upper Eocene-Oligocene – Washington-Oregon), *R. oregonensis* Rathbun, 1926 (Oligocene – Oregon), *R. goedertorum* (Tucker, 1998) (Upper Eocene – Washington), *R. vaderensis* Rathbun, 1926 (Middle-Upper Eocene – Pacific Northwest), *R. dickersoni* Rathbun, 1926 (Middle Eocene – California), *R. acanthocolus* Schweitzer, Feldmann, González-Barba & Ćosović, 2006 (Eocene – Baja California), *R. proracanthus* Schweitzer *et al.*, 2006 (Eocene – Baja California), *R. slaki* Squires, 2001 (Eocene – California), *R. bournei* (Rathbun, 1928) (Paleocene – southcentral United States), *R. borealis* (Collins & Rasmussen, 1992) (Middle Paleocene – Greenland), *R. araucana* (Philippi, 1887) (Lower Eocene – Chile). Four fossil species are known from Indo-Pacific area: *R. sinuosus* (Collins & Morris, 1978) (Lower Eocene – Pakistan), *R. javanus* (Böhm, 1922) (Miocene – Java), *R. nodai* Karasawa, 1992 (Middle-Upper Eocene – Japan), *R. perarmata* (Glaessner, 1960) (Middle Eocene – New Zealand), *R. morrisi* Collins, Lee & Noad (Miocene – Borneo). Eigth fossil species are known from Europe: *R. glabra* (Woodward, 1871) (Lower Eocene – England), *R. gottschei* Böhm, 1927 (Lower Eocene – England), *R. treldenaesensis* Collins & Jakobsen, 2003 (Eocene – Denmark), *R. notopoides* (Bittner, 1883) (Eocene – Italy), *R. pulchra* (Beschin, Busulini, De Angeli & Tessier, 1988) (Middle Eocene – NE Italy), *R. budapestiniensis* (Lőrenthey, 1897) (Middle-Upper Eocene – Hungary and Italy), *R. fabianii* (Lőrenthey & Beurlen, 1929) (Middle-Upper Eocene – Hungary and Italy); *R. hollandica* (Collins, Fraaye, Jagt & v. Knippenberg, 1997) (Upper Oligocene - The Netherlands), and *R. pliocenicus* n. sp. (Pliocene – Italy).

Raninoides pliocenicus n. sp. shows most morphological affinities with *R. fabianii* (Lőrenthey & Beurlen, 1929) from the Upper Eocene of Hungary, Italy,

and probably Germany. In fact, this species also has a rostrum with rounded tip and elongate fissures on supraorbital margins (Lőrenthey & Beurlen, 1929; Förster & Mundlos, 1982; Beschin *et al.*, 2006). However *Raninoides fabianii* differs in having a longitudinal depression on the dorsal surface of the rostrum and ornamentation of dorsal surface of carapace with granules of different size.

Among the European species: *R. hollandica* differs from *R. pliocenicus* n. sp. for the narrower anterior margin and antero-lateral margins with small ridges; *R. glabra* has instead a wider carapace and stronger antero-lateral spines; *R. gottschei* differs in having rostrum narrower, almost straight supraorbital margin, and dorsal surface ridged in the median part; *R. reldenaesensis* has a longer carapace and less convex lateral margins; *R. pulchra* has rostrum shorter, bifid anterolateral spines, and smooth dorsal surface of carapace; *R. budapestiniensis* and *R. notopoides* both have shorter carapace.

Raninoides pliocenicus n. sp. represents the youngest species of the genus in Europe.
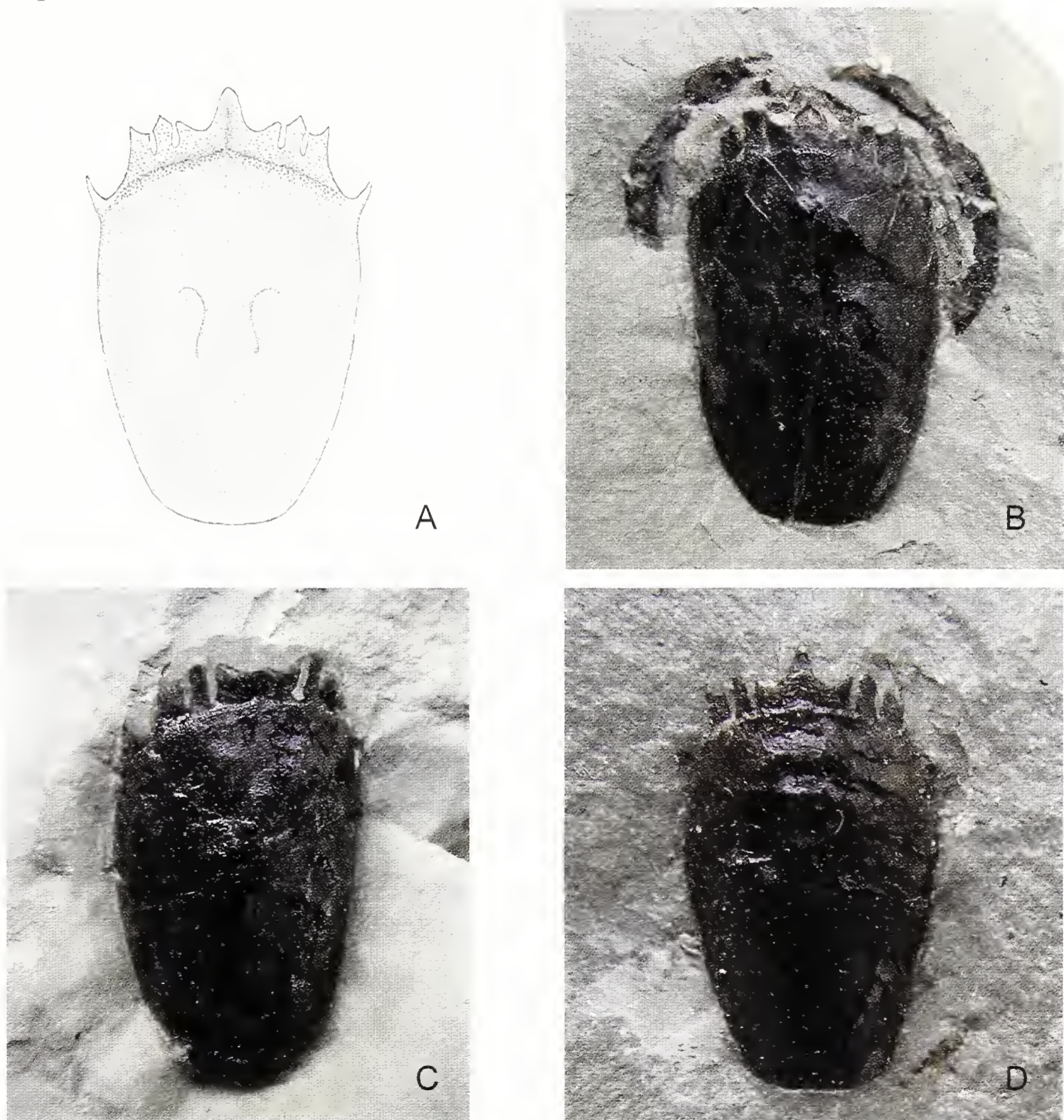
Fig. 5 – *Raninoides pliocenicus* n. sp. A) reconstruction of carapace/ricostruzione del carapace. B) CF-TCR1, paratype/paratipo (x 1.5). C) GPDG 0067, paratype/paratipo (x 1.8). D) GPDG 0068, holotype/olotipo (x 2.7).

Subsection Eubrachyura Saint Laurent, 1980
Subsection Heterotremata Guinot, 1977
Superfamily Dorippoidea MacLeay, 1838
Family Dorippidae MacLeay, 1838
Genus *Medorippe* Manning & Holthuis, 1981

Type species: *Cancer lanatus* Linnaeus, 1767.

Medorippe ampla Garassino, De Angeli, Gallo & Pasini, 2004
Fig. 6

2004 – *Medorippe ampla* Garassino, De Angeli, Gallo & Pasini; p. 260, Text-figs. 5, 6 a-b
2006 – *Medorippe ampla* Garassino, De Angeli, Gallo & Pasini *in* De Angeli & Garassino; p. 40

Stratigraphic range: Upper Miocene (Messinian).
Type locality: Rio Popogna (Livorno).
Material and measurements: two complete specimens in dorsal view.
GPDG 0070 – lcxp: 10.5; wcxp: 12.7; wo-f: 7.4
GPDG 0071 – lcxp: 12.5; wcxp: 14.4; wo-f: 9.6

Discussion. *Medorippe ampla* was described by two specimens from the Messinian (Upper Miocene) of Cocconato (Asti, Piemonte) (Garassino *et al*., 2004). The main morphological characters of the species are as follows: subhexagonal carapace, weakly convex, wider than long; wide orbito-frontal margin; bilobate front; wide orbits marked by a well developed extraorbital tooth; divergent antero-lateral margins with an epibranchial spine; elongate postero-lateral margins; well marked regions with granulations; deep cervical and cardiac grooves; narrow cardiac region with Y-shaped granulate ridge anteriorly; hepatic and branchial regions with granulate ridges. The studied specimens have the same characters as the type specimens from Piemonte. The only difference is a lower density of granulation on the ridges of the carapace regions.

Fig. 6 – *Medorippe ampla* Garassino, De Angeli, Gallo & Pasini, 2004, GPDG 0070 (x 3.7).

Family Ethusidae Guinot, 1977
Genus *Ethusa* Roux, 1830

Type species: *Cancer mascarone* Herbst, 1785.

Ethusa popognensis n. sp.
Fig. 7 A-B

Diagnosis: carapace longitudinally ovate, wider posteriorly; front with four teeth; antero-lateral margins elongate and divergent; posterior margin concave; distinct regions with small tubercles in median part; branchial regions with two grooves and two granulate ridges.

Etymology: the trivial name alludes to Rio Popogna where the studied specimen was discovered.

Holotype: GPDG 0072.

Stratigraphic range: Upper Miocene (Messinian).

Type locality: Rio Popogna (Livorno).

Material and measurements: one complete specimen in dorsal view.

GPDG 0072 – lcxp: 18.3; wo-f: 10.2

Description: carapace slightly convex transversely, longitudinally ovate, wider posteriorly. Orbito-frontal margin occupies the entire anterior part of dorsal surface. Front about 2/5 of orbito-frontal width. Front with two pairs of triangular teeth separated by a V-shaped depression in median part. Orbits narrow. Supraorbital margins marked by a narrow fissure. Preorbital margin slightly raised. Strong extraorbital tooth somewhat elongate. Antero-lateral margins elongate and divergent. Postero-lateral margins converge strongly to posterior margin. Posterior margin wide, concave in median part, and ridged superficially. Dorsal regions distinct. One weak longitudinal groove in frontal region. Protogastric region marked by a weak hepatic groove. Metagastric, urogastric, and cardiac regions well marked along margins by branchiocardiac groove. Oval cardiac region. Intestinal region depressed. Subtriangular hepatic region, separated from branchial regions by cervical groove. Small oval dip close to the depression of cervical groove. Well-developed branchial regions crossed transversely by two branchial grooves forming two granulate ridges. Dorsal regions smooth. Small tubercles are located in the median part of gastric, cardiac, hepatic, and branchial regions.

A

B

Fig. 7 – *Ethusa popognensis* n. sp., GPDG 0072, holotype/olotipo. A) dorsal view/norma dorsale (x 2.2). B) reconstruction of carapace/ricostruzione del carapace.

Discussion. *Ethusa* Roux, 1830, includes 43 Recent species (Ng *et al.*, 2008) widespread usually in shallow environments. The rare fossil species are restricted to the Cenozoic. *Ethusa chibai* Karasawa, 1993 (Lower Pliocene, Japan) differs from *E. popognensis* n. sp. by exhibiting a carapace longer, dorsal surface of carapace smoother, and shallow branchiocardiac grooves. *Ethusa evae* Müller & Collins, 1991 [Upper Eocene (Priabonian), Hungary] has instead a subsquare carapace and orbits wider. *Ethusa berica* De Angeli & Beschin, 2008 (Lower Oligocene, Vicenza, Italy) has a carapace longer and smooth and extraorbital spines more developed and directed obliquely.

Müller (1984b) and Via Boada (1988) have reported the presence of a probable new subspecies of *E. mascarone* (Herbst, 1785) from the Messinian (Miocene) of Santa Pola (Alicante, Spain). Artal & Gilles (2007) have recorded *Ethusa* sp. from the Miocene of Pignan (southeast France). Marangon & De Angeli (2007) have recorded a new species of *Ethusa* from the Lower Oligocene of Bacino Ligure Piemontese having a carapace longer with smooth regions.

Superfamily Calappoidea H. Milne Edwards, 1837
Family Calappidae H. Milne Edwards, 1837
Genus *Calappa* Weber, 1795

Type species: *Cancer granulatus* Linnaeus, 1758.

Calappa granulata (Linnaeus, 1758)
Fig. 8 A-B

1758 – *Cancer granulatus* Linnaeus; p. 627
1767 – *Cancer granulatus* Linnaeus; p. 533
1798 – *Calappa granulata* (Linnaeus) *in* Fabricius; p. 346
1816 – *Calappa granulata* (Linnaeus) *in* Risso; p. 18
1825 – *Calappa granulata* (Linnaeus) *in* Desmarest; p. 109, Pl. 10 (fig. 1)
1828 – *Calappa granulata* (Linnaeus) *in* Roux; Pl. 2 (Fig. 13), Pl. 16 (figs. 1-7)
1861b – *Calappa granulata* (Linnaeus) *in* A. Milne Edwards; p. 88
1863 – *Calappa granulata* (Linnaeus) *in* Heller; p. 130, Pl. 4 (fig. 3)
1914 – *Calappa granulata* (Linnaeus) *in* M. Gemmellaro; p. 80, Pl. 1 (figs. 9-10)
1918 – *Calappa granulata* (Linnaeus) *in* Pesta; Text-fig. 97
1929 – *Calappa granulata* (Linnaeus) *in* Glaessner; p. 70
1936 – *Calappa granulata* (Linnaeus) *in* Nobre; p. 81, Pl. 28 (figs. 73-74)
1940 – *Calappa granulata* (Linnaeus) *in* Bouvier; p. 203, Text-fig. 203, Pl. 7 (fig. 1)
1946 – *Calappa granulata* (Linnaeus) *in* Zariquiey Alvarez; p. 143, Text-fig. 163
1965 – *Calappa granulata* (Linnaeus) *in* Forest; p. 362
1968 – *Calappa granulata* (Linnaeus) *in* Zariquiey Alvarez; p. 315, Text-figs. 105 c, 107 a
1992 – *Calappa granulata* (Linnaeus) *in* Falciai & Minervini; p. 181, Pl. 12 (fig. 4)
2004a – *Calappa granulata* (Linnaeus) *in* Garassino & De Angeli; p. 38, Text-fig. 4 (1-3)
2004 – *Calappa granulata* (Linnaeus) *in* Garassino, De Angeli, Gallo & Pasini; p. 264, Text-fig. 7 a-c
2006 – *Calappa granulata* (Linnaeus) *in* De Angeli & Garassino; p. 40

Stratigraphic range: Lower Pliocene (Piacentian).
Type locality: Presciano and Terre Rosse (Siena).
Material and measurements: one complete specimen in dorsal view (GPDG 0073 from Presciano); one movable finger of right cheliped (GPDG 0074 from Stroncoli).
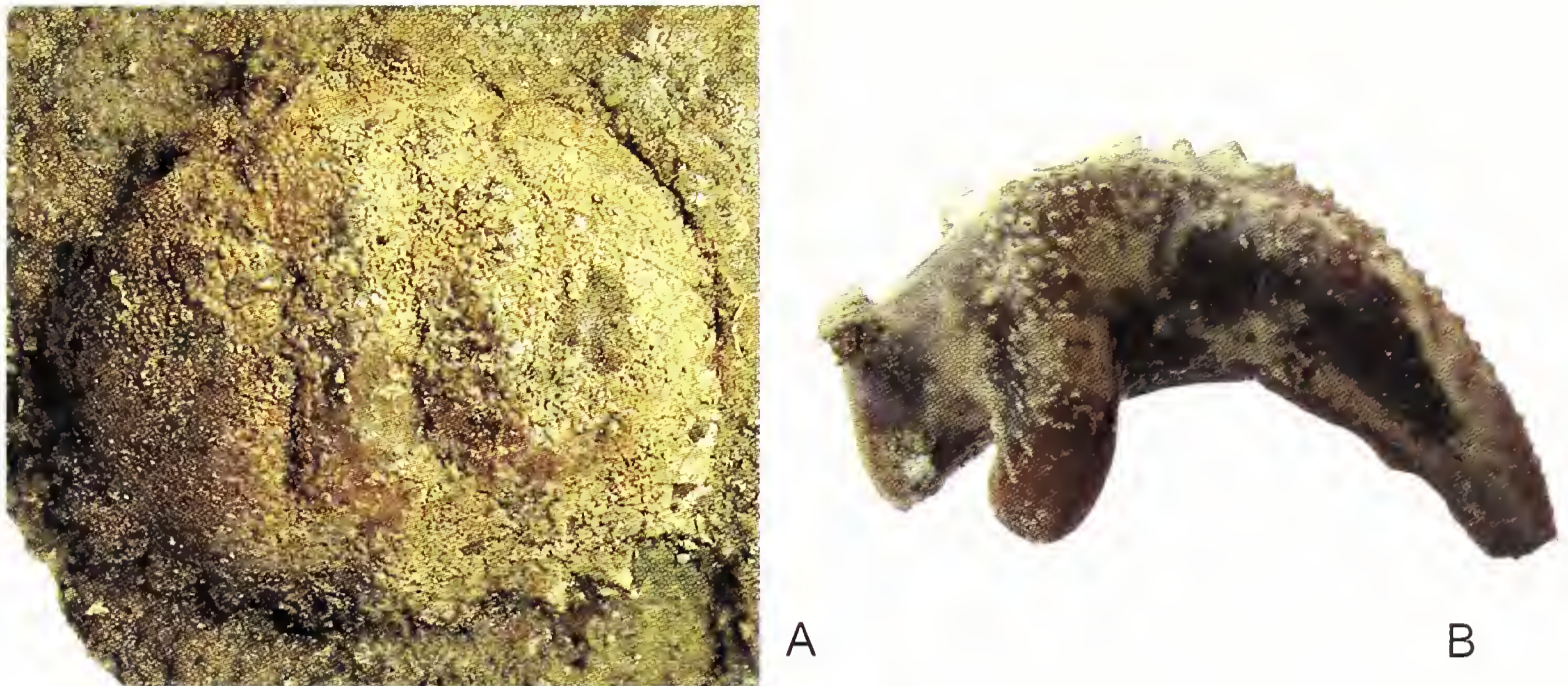
Fig. 8 – *Calappa granulata* (Linnaeus, 1758). A) GPDG0073 (x 1.7). B) GPDG 0074, dactylus (x 3).

GPDG 0073 – lcxp: 22.8; wcxp: 27.9; wo-f: 9.4
GPDG 0074 – lmf: 20.3

Discussion. The carapace is suboval, slightly convex, and mainly elevated in the posterior part. The front is narrow and bilobate. The supra-orbital margins are short and slightly raised. The antero-lateral margins are convex with small teeth. The postero-lateral margins are strongly convergent with triangular teeth. The regions are well marked by two longitudinal grooves which divide the dorsal surface of carapace into three parts. Some tubercles are present on the branchial regions.

Even though the specimen from Presciano is not well preserved, it shows close morphological affinities with *Calappa granulata* (Linnaeus, 1758), already known from the Pliocene of Orciano (Pisa), Altavilla (Palermo), Emilia Romagna, and from the Pleistocene of Monte Pellegrino (Palermo, Sicilia) (Ristori, 1891; M. Gemmellaro, 1914; Garassino & De Angeli, 2004).

Superfamily Leucosioidea Samouelle, 1819
Family Leucosiidae Samouelle, 1819
Genus *Ebalia* Leach, 1817

Type species: *Ebalia bryerii* Leach, 1817.

Ebalia cfr. *E. deshayesi* Lucas, 1846
Fig. 9

Stratigraphic range: Lower Pliocene (Zanclean-Piacentian).
Type locality: Poggio alla Staffa (Siena).
Material and measurements: one complete specimen in dorsal view.
GPDG 0075 – wcxp: 5.6

Description: Small-sized specimen lacking the front. Octagonal carapace, slightly wider than long, convex dorsally having small irregular tubercles. Antero-lateral margins as long as the postero-lateral margins. The median parts of lat-

eral margins are parallel and slightly concave. The postero-lateral margins have a marked concavity. The posterior margin has the median part slightly concave and posterior angles with two strong rounded protuberances. The dorsal regions are not distinct. The gastric region has three granulate protuberances: one mesogastric and one on both protogastric regions. Other two granulate protuberances are present on the branchial regions. The cardiac region has a wide and developed oval bulge.

Discussion. The high degree of sexual dimorphism among adults, the remarkable morphological differences between adults and juvenile stages, and the extremely variable morphology of carapace in the same species, makes the right classification of the species ascribed to this genus difficult.

The studied specimen shows morphological affinities with the Recent *Ebalia deshayesi* Lucas, 1846, widespread in Atlantic (Balearic Islands) and Mediterranean Sea, living in sandy and muddy bottoms (Zariquiey Alvarez, 1968). Common characters between the fossil specimen and the Recent species are the octagonal carapace, slightly wider than long, having gastric and branchial protuberances. However the studied specimen differs from the Recent species in having the postero-lateral margins more concave.
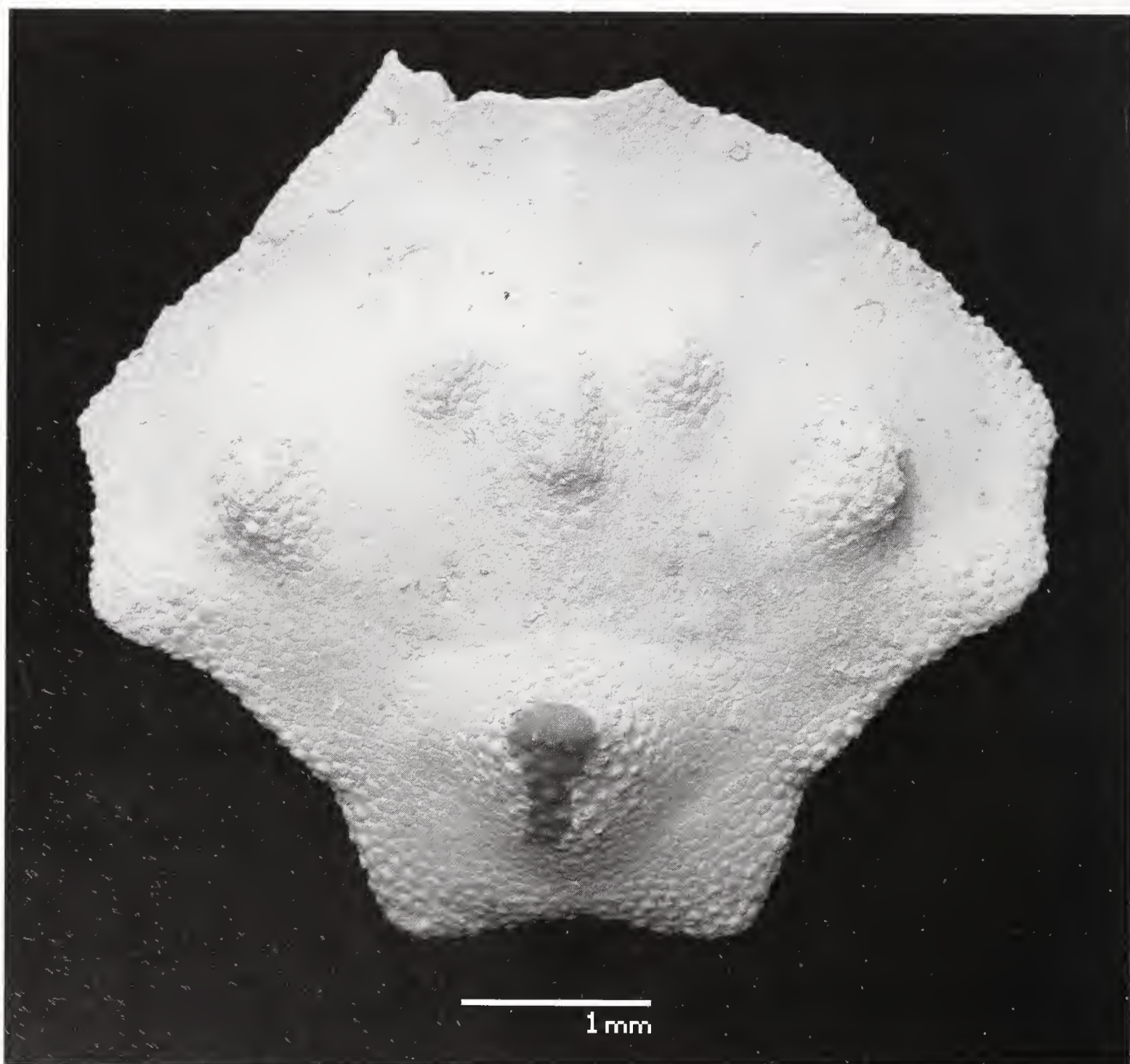
Fig. 9 – *Ebalia* cfr. *deshayesi* Lucas, 1846, GPDG0075.

Ebalia cranchii Leach, 1817
Fig. 10

1817 – *Ebalia cranchii* Leach; Pl. 25 (figs. 7-11)
1846 – *Ebalia cranchii* Leach *in* Bell; p. 148
1855 – *Ebalia cranchii* Leach *in* Bell; p. 303
1891b – *Ebalia cranchii* var. *romana* Ristori; p. 22, Pl. 1 (figs. 21-23), **nov. syn.**
1892a – *Ebalia cranchii* Leach *in* Ristori; p. 88
1914 – *Ebalia cranchii* var. *romana* Ristori *in* M. Gemmellaro; p. 78, Pl. 1 (figs. 3-6)
1929 – *Ebalia cranchii* var. *romana* Ristori *in* Glaessner; p. 144
1936 – *Ebalia cranchii* Leach *in* Nobre; p. 78, Pl. 26 (fig. 64)
1940 – *Ebalia cranchii* Leach *in* Bouvier; p. 209, Pl. 7 (figs. 7-10)
1946 – *Ebalia cranchii* var. *romana* Ristori *in* Maxia; p. 132, Pl. 1 (fig. 1)
1956 – *Ebalia cranchii* Leach *in* Monod; p. 122, Text-figs. 145-146
1965 – *Ebalia cranchii* Leach *in* Forest; p. 364-371, Text-fig. 25 a-b, Pl. 2 (figs. 1-2)
1968 – *Ebalia cranchii* Leach *in* Zariquiey Alvarez; p. 329, Text-figs. 108 a-b, 111 b, d, 111 A, a, 111 C, b
1981 – *Ebalia cranchii* var. *romana* Ristori *in* Delle Cave; p. 45
1992 – *Ebalia cranchii* Leach *in* Falciai & Minervini; p. 184
2004a – *Ebalia cranchii* Leach *in* Garassino & De Angeli; p. 39, Text-figs. 3 (7, 8), 4 (4), 5, 6
2006 – *Ebalia cranchii* Leach *in* De Angeli & Garassino; p. 45

Stratigraphic range: Plio-Pleistocene.
Type locality: Parrana San Giusto (Livorno).
Material and measurements: one complete carapace.
GPDG 0089: lcxp: 5.4; wcxp: 5.1

Fig. 10 – *Ebalia cranchii* Leach, 1817, GPDG0089 (x 10).

Discussion. The studied specimen shows morphological affinities with *Ebalia cranchii* Leach, 1817, widespread in the Mediterranean Sea and discovered in the fossil record from the Pliocene and Pleistocene of Emilia Romagna, Lazio, and Sicilia (Ristori, 1891; M. Gemmellaro, 1914; Maxia, 1946; Garassino & De Angeli, 2004). The carapace is longer than wide, with convex lateral margins and dorsal surface with five weak granulate protuberances. The front is wider and more raised superficially than *Ebalia* cfr. *E. deshayesi* Lucas, 1846, and *E. fucinii* Ristori, 1892. Many specimens of *E. cranchii* have been recently reported from the Pliocene and Pleistocene of Emilia Romagna by Garassino & De Angeli (2004).

Ebalia fucinii Ristori, 1892
Fig. 11

1892 – *Ebalia fucinii* Ristori, p. 88, fig. 2
1929 – *Ebalia fucinii* Ristori *in* Glaessner, p. 144
1981 – *Ebalia fucinii* Ristori *in* Delle Cave, p. 45
2004 – *Ebalia fucinii* Ristori *in* Garassino & De Angeli, p. 40
2006 – *Ebalia fucinii* Ristori *in* De Angeli & Garassino, p. 43

Stratigraphic range: Plio-Pleistocene.
Type locality: Parrana San Giusto (Livorno).

Fig. 11 – *Ebalia fucinii* Ristori, 1892, GPDG0076.

Material and measurements: one complete specimen in dorsal view.
GPDG 0076 – lcxp: 4.9; wcxp: 5.1

Description: Octagonal carapace, slightly wider than long, superficially concave, having small and weak irregular tubercles. The orbito-frontal margin is about 1/3 the maximum width of carapace. The front is incomplete in the distal part. The orbits are rounded and marked by two narrow supraorbital fissures. The antero-lateral margins are as long as the postero-lateral margins. The median parts of lateral margins are almost parallel with slightly concave margins. The posterior parts of lateral margins form an acute angle, raised superficially, extending onto the branchial regions by a weak oblique ridge. The postero-lateral margins are concave. The posterior margin is slightly concave in tha median part with two rounded protuberances on the angles. Dorsal regions are not distinct. The cardiac region has a large oval bulge.

Discussion. The studied specimen shows morphological affinities with *Ebalia fucinii*, described by Ristori (1892) from the Pliocene of Spicchio (Empoli).

Genus *Ilia* Leach, 1817

Type species: *Cancer nucleus* Linnaeus, 1758.

Ilia pliocenica Ristori, 1891
Fig. 12 A-B

1891 – *Ilia pliocenica* Ristori; p. 10, Pl. 1 (figs. 8, 9, 11-12, 14)
1892 – *Ilia pliocenica* Ristori *in* Ristori; p. 86
1929 – *Ilia pliocenica* Ristori *in* Glaessner; p. 225
1981 – *Ilia pliocenica* Ristori *in* Dalle Cave; p. 45
2004 – *Ilia pliocenica* Ristori *in* Garassino & De Angeli; p. 40, fig. 4 (5)
2004 – *Ilia pliocenica* Ristori *in* Garassino, De Angeli, Gallo & Pasini; p. 266, figs. 8 a, b
2006 – *Ilia pliocenica* Ristori *in* De Angeli & Garassino; p. 46
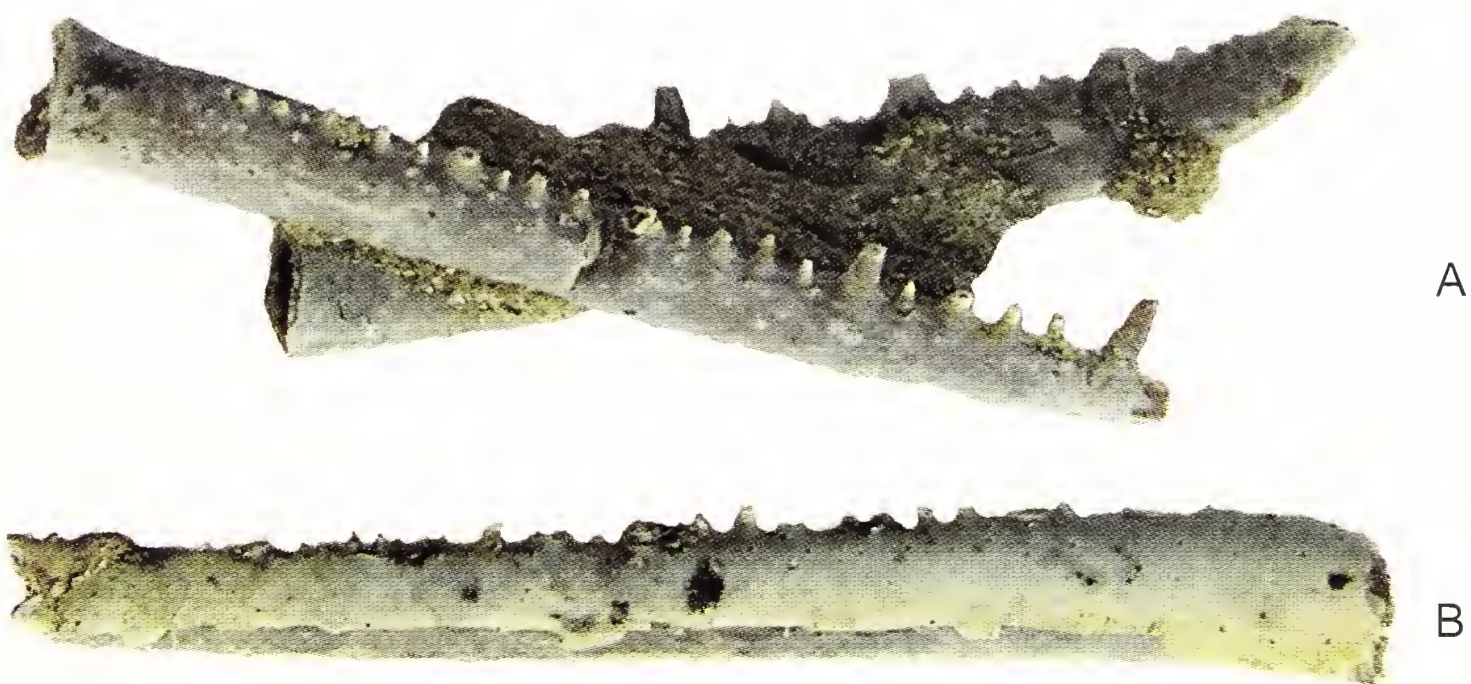
Fig. 12 – *Ilia pliocenica* Ristori, 1891, movable finger or fixed finger / dito mobile o dito fisso. A) GPDG 0077 (x 9). B) GPDG 0078 (x 10)

Stratigraphic range: Lower Pliocene (Zanclean-Piacentian).

Type locality: Ciuciano and Pietrafitta (Siena).

Material: four specimens (fragments of chelipeds) (GPDG 0077, 0078 from Pietrafitta; 0079, 0080 from Ciuciano).

Discussion. The studied specimens include fragments of elongated movable and fixed fingers, with the occlusal margin having many perpendicular spines of different size. *Ilia pliocenica* has been recorded from the Pliocene and Pleistocene of Spicchio (Empoli), Arda River (Piacenza), Masserano, and Cossalto (Biella) (Ristori, 1891; Garassino & De Angeli, 2004; Garassino *et al*., 2004). *Ilia pliocenica* probably represents the ancestor of the Recent species *I. nucleus* Linnaeus, 1758, that is widespread in the Mediterranean Sea.

Genus *Palaeomyra* A. Milne Edwards, 1861

Type species: *Palaeomyra bispinosa* A. Milne Edwards *in* E. Sismonda, 1861.

Palaeomyra bispinosa A. Milne Edwards, 1861
Fig. 13

1861 – *Palaeomyra bispinosa* A. Milne Edwards *in* Sismonda, p. 16, Figs. 18-20
1969 – *Palaeomyra bispinosa* A. Milne Edwards *in* Glaessner, p. R498
2004 – *Palaeomyra bispinosa* A. Milne Edwards *in* Garassino, De Angeli, Gallo & Pasini, p. 267, Figs. 9, 10 a, b
2006 – *Palaeomyra bispinosa* A. Milne Edwards *in* De Angeli & Garassino, p. 46

Stratigraphic range: Pliocene *sensu lato*.

Type locality: La Strolla (Siena).

Material and measurements: one complete specimen in dorsal view.
GPDG 0081 – lcxp: 12.7; wcxp: 9.9; wf: 4.2

Fig. 13 – *Palaeomyra bispinosa* A. Milne Edwards, 1861, GPDG 0081 (x 4.3).

Discussion. *Palaeomyra* was described by A. Milne Edwards *in* E. Sismonda (1861), based upon the morphological characters of *P. bispinosa* A. Milne Edwards *in* E. Sismonda (1861), represented by one inner cast of a carapace from the Miocene of Torino (Piemonte). Recently Garassino *et al.* (2004) have recorded six complete specimens of this species from the Oligocene of Morbello (Alessandria) and from the Miocene of Cocconato (Asti).

The studied specimen shows the typical morphological characters of this species, even though the spines located on the angles are less developed of those of the specimens from Piemonte.

Palaeomyra bispinosa is similar to *P. globulosa* (Müller, 1976) from the Miocene of Hungary. However the Hungarian species has a more elongate carapace and more tuberculate dorsal surface. *Palaeomyra* shows close morphological affinities with the Recent *Pseudomyra mbizi* Capart, 1951, widespread along the western coasts of Africa.

Superfamily Portunoidea Rafinesque, 1815
Family Portunidae Rafinesque, 1815
Subfamily Polybiinae Ortmann, 1893
Genus *Liocarcinus* Stimpson, 1871

Type species: *Portunus holsatus* Fabricius, 1798.

Liocarcinus sp.
Fig. 14

Stratigraphic range: Lower Pliocene (Zanclean-Piacentian).
Type locality: Pietrafitta (Siena).
Material: two fixed fingers of propodi of chelipeds (GPDG 0082, 0083).
Discussion. The two studied specimens include only fixed fingers belonging to the right and left propodi of chelipeds. The fixed fingers are elongate and curved with a lower concave margin and occlusal margin with some teeth. The outer surface has two longitudinal ridges and one row of orifices, aligned longitudinally. These fixed fingers show close affinities with those of the representatives of *Liocarcinus* Stimpson, 1871, widespread in the Mediterranean Sea from the Miocene to Recent.
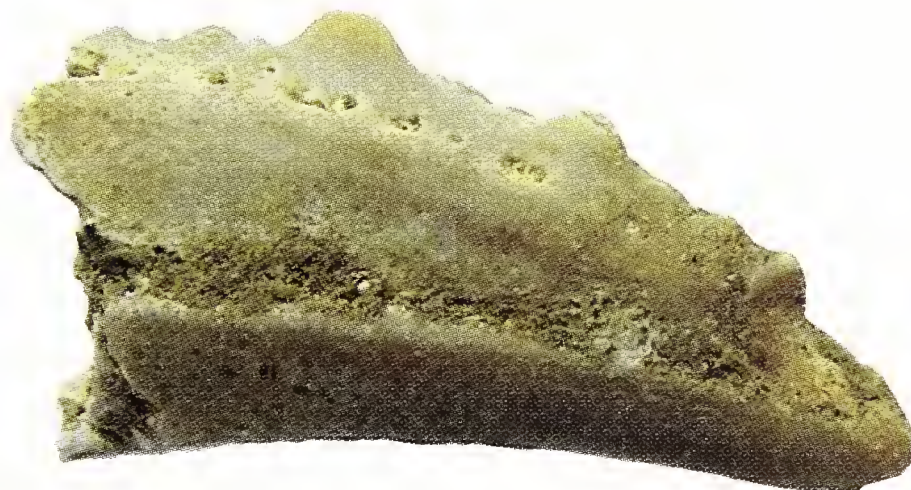
Fig. 14 – *Liocarcinus* sp., GPDG 0082, fixed finger/dito fisso (x 7).

Superfamily Pilumnoidea Samouelle, 1819
Family Pilumnidae Samouelle, 1819
Genus *Pilumnus* Leach, 1815

Type species: *Cancer hirtellus* Linnaeus, 1761.

Pilumnus ristorii new replacement name for *Pilumnus spinosus* Ristori, 1886
Fig. 15

Stratigraphic range: Lower Pliocene (Piacentian).
Type locality: Terre Rosse (Siena).
Material and measurements: one right propod.
GPDG 0069 – lp: 5.5; h: 5.9; tp: 3.2; lt: 9.4

Description. Suboval carpus, raised superficially, with upper margin and outer surface having strong spines. Subcylindrical propodus, longer than wide. Upper margin slightly convex with four pointed spines. Lower margin almost straight. Outer surface with rows of spines. Spines of upper margin and upper part of outer surface incomplete distally. Spines of lower part of outer surface small or with small tubercles. Fixed finger incomplete slightly directed backwards with some tubercles.

Discussion. The shape and the ornamentation with strong spines located in longitudinal rows resemble *Pilumnus spinosus* Ristori, 1886, described by one carpus and one propodus of a right chela from the Middle Pliocene of S. Venanzio (Modena). The propodus described by Ristori shows fewer rows of spines covering only the upper and medial parts of the outer surface, while in the studied specimen the outer surface is totally covered by rows of spines or tubercles. Probably the presence of many rows of spines is correlated with sexual dimorphism.

Pilumnus spinosus Ristori, 1886, was preoccupied by *Pilumnus spinosus* Filhol, 1885. Thus, we provide herein the new replacement name *Pilumnus ristorii* to replace *Pilumnus spinosus* Ristori, 1886.

Fig. 15 – *Pilumnus ristorii* new replacement name, GPDG 0069, right propod/propodus destro (x 10)

Superfamily Xanthoidea MacLeay, 1838
Family Xanthidae MacLeay, 1838
Genus *Monodaeus* Guinot, 1967

Type species: *Xantho couchii* Couch, 1815.

Monodaeus bortolottii Delle Cave, 1988
Fig. 16

Stratigraphhic range: Pliocene *sensu lato*.

Type locality: Monterotondo Marittimo (Grosseto).

Material and measurements: one carapace incomplete in anterior part.

IGF 14636E – lcxp: 8; wcxp: 10.8

Discussion. Suboctagonal carapace, wider than long, slightly convex superficially. Front with margin almost straight with one weak median incision. Supraorbital margins separated from the front by a depression. Antero-lateral margins short, convex, and serrate. Postero-lateral margin long and convergent. Posterior margin straight in median part and convex on margins with a granulate ridge. Dorsal regions well marked by grooves. Frontal region wide and depressed in median part. Epigastric lobes wide and raised. Suboval protogastric regions well marked. Subpentagonal mesogastric regions with anterior process narrow and elongate between protogastric regions. Wide cardiac region well marked by branchiocardiac grooves. Hepatic regions small and poorly marked. Branchial regions wide and well marked. Dorsal surface with small tubercles. Anterior regions with some granulate striae.

The studied specimen shows morphological affinities with *Monodaeus bortolottii* Delle Cave, 1988, described by one inner mould of carapace with chelipeds partially preserved from the Lower Pliocene (Piacentian) of Botro dell'Alpino, close to Volterra.

Fig. 16 – *Monodaeus bortolottii* Delle Cave, 1988, IFG 14636E (x 5.5).

Superfamily Eriphioidea MacLeay, 1838
Family Eriphiidae MacLeay, 1838
Genus *Eriphia* Latreille, 1817

Type species: *Cancer spinifrons* Herbst, 1785.

Eriphia cocchii Ristori, 1886
Figs. 17 A-B

1886 – *Eriphia cocchii* Ristori; p. 105, Pl. 2 (figs. 3, 4, 11, 13), Pl. 3 (figs. 1, 2)
1886 – *Eriphia punctulata* Ristori; p. 109, Pl. 2 (figs. 2, 15, 16)
1891 – *Eriphia cocchii* Ristori *in* Ristori; p. 9
1910 – *Eriphia cocchii* Ristori *in* Fucini; p. 3, figs. 1 a, c, 2
1929 – *Eriphia cocchii* Ristori *in* Glaessner; p. 149
1981 – *Eriphia cocchii* Ristori *in* Delle Cave; p. 46
1981 – *Eriphia punctulata* Ristori *in* Delle Cave; p. 47
2006 – *Eriphia cocchii* Ristori *in* De Angeli & Garassino; p. 67

Stratigraphic range: Lower Pliocene (Zanclean-Piacentian).

Type locality: Balconevisi (San Miniato – Pisa), Pietrafitta and Terre Rosse (Siena).

Material and measurements: one complete specimen from Balconevisi (San Miniato – Pisa) (MSNM i27214); one fixed finger of right cheliped from Pietrafitta (Siena) (MSNM i27215); one movable finger of right cheliped from Terre Rosse (Siena) (GPDG 0084).

Fig. 17 – *Eriphia cocchii* Ristori, 1886, MSNM i27214. A) frontal view/norma frontale. B) dorsal view/norma dorsale (x 0.6).

MSNM i27214 – lcxp: 45; wcxp: 60.6; wo-f: 44.2
MSNM i27215 – lff: 23.7
GPDG 0084 – lmf: 20.1

Discussion. The complete specimen has a carapace with spinose frontal margin and antero-lateral margins. The orbits have a raised, serrated margin with some spines. The regions are not well marked and only slightly granulated. Some tubercles are present on hepatic regions. The chelae are well developed, heterochelous, with carpus and propodus having spines.

Eriphia cocchii has been recorded from the Pliocene of Montrappoli (Val d'Elsa – Firenze) and Montebicchieri (San Miniato – Pisa) (Ristori, 1886). Later Fucini (1910) reported one specimen of this species from the Pliocene of Spicchio (Empoli). Moreover Fucini (1910) considered *E. punctulata*, described by Ristori (1886) from the Pliocene of Montrappoli as synonymous of *E. cocchii*.

Family Goneplacidae MacLeay, 1838
Subfamily Goneplacinae MacLeay, 1838
Genus *Goneplax* Leach, 1814

Type species: *Cancer rhomboides* Linnaeus, 1758.

Goneplax gulderi Bachmayer, 1953
Fig. 18 A-B

1895 – *Goneplax sacci* Crema; p. 674, Text-fig. 15
1907 – *Goneplax* cfr. *sacci* Crema *in* Lőrenthey; p. 94, Pl. 3 (figs. 4 a-c, 6-7), Pl. 4 (fig. 6)
1909 – *Goneplax* cfr. *sacci* Crema *in* Lőrenthey; p. 249, Pl. 1 (fig. 4 a-c, 6-7), Pl. 2 (fig. 6)
1929 – *Goneplax saccoi* Crema *in* Glaessner; p. 199
1948 – *Goneplax* cfr. *saccoi* Crema *in* Via Boada; p. 146, Pl. 1 (fig. 6)
1953 – *Goneplax gulderi* Bachmayer; p. 143, Pl. 9 (figs. 1-3)
1984 – *Goneplax gulderi* Bachmayer *in* Müller; p. 96, Pl. 93 (figs. 2-3)
1988 – *Goneplax* cfr. *saccoi* Crema *in* Solé & Via Boada; p. 34
1993 – *Goneplax gulderi* Bachmayer *in* Müller; p. 23, Text-fig. 11 K
1998 – *Goneplax gulderi* Bachmayer *in* Mayoral, Müller e Muñiz; p. 508, Text-fig. 2 (5)
1998 – *Goneplax gulderi* Bachmayer *in* Müller; p. 38
2004 – *Goneplax gulderi* Bachmayer *in* Garassino & De Angeli; p. 45
2006 – *Goneplax gulderi* Bachmayer *in* De Angeli & Garassino; p. 65

Stratigraphic range: Upper Miocene (Messinian); Pliocene *sensu lato*.
Type locality: Rio Popogna (Livorno), Monterotondo Marittimo (Grosseto).
Material and measurements: 11 complete specimens of which one in ventral view (male, CF-TCR2). GPDG 0085-0087 (Rio Popogna), GPDG 0088, CF-TCR2 (Monterotondo Marittimo), MSNM i27082-i27087 (Rio Popogna).

MSNM i27082 – lcxp: 15; wcxp: 15.5
MSNM i27083 – lcxp: 14.1; wcxp: 16.5
MSNM i27084 – lcxp: 15.8; wcxp: 18.7
MSNM i27085 – lcxp: 12.6; wcxp: 14.2
MSNM i27086 – lcxp: 10; wcxp: 12.2
MSNM i27087 – lcxp: 12; wcxp: 12.5
GPDG 0085 – lcxp: 16.5; wcxp: 18.3
GPDG 0086 – lcxp: 10.6; wcxp: 11.5

GPDG 0087 – wcxp: 13.9
GPDG 0088 – lcxp: 12; wcxp: 13.6
Cf-TCR2 – male ventral parts preserved.

Discussion. Müller (1993) recorded some specimens from the Neogene of Catalonia (Spain), discussing species of *Goneplax* from the Miocene-Pleistocene of Mediterranean area. The two fossil species from the Pliocene of Italy, *G. formosa* Ristori, 1868, and *G. meneghinii* Ristori, 1868, were considered by some authors as probably synonymous with the Recent Mediterranean species, *G. rhomboides* (Lin-

Fig. 18 – A) *Goneplax gulderi* Bachmayer, 1953, GPDG0085, dorsal view/norma dorsale (x 3.5). B) *Goneplax gulderi* Bachmayer, 1953, CF-TCR2, ventral view/norma ventrale (x 2).

naeus). In fact the carapace of *G. rhomboides* is extremely variable. Its fossil record from the Pliocene and Pleistocene of Italy was discussed by some authors (last reference Garassino & De Angeli, 2004). Müller (1993) distinguished *G. gulderi* Bachmayer, 1953, from *G. rhomboides* on the presence of the two well-marked transverse ridges on the carapace and the anterior margin where every orbit is as wide as the wide of the front; in *G. rhomboides* the orbits are more developed with respect to the width of the front.

Finally, Müller (1993) discussed the characters of the holotype of *G. sacci* Crema, 1895 (= *G. saccoi in* Glaessner, 1929) from the Miocene of Monte Capriolo (Bra – Cuneo). Even though the holotype of this species is not well preserved, it has the orbito-frontal margin very similar to that of *G. gulderi*. For this reason Müller (1993) considered *G. sacci* to be a probable synonym of *G. gulderi*.

The studied specimens confirm the observations made by Müller and therefore they are ascribed to *G. gulderi*. This species has been recorded from the Miocene (Badenian) of Austria and Hungary, from the Pliocene (Tortonian) of Spain, and from the Miocene-Pliocene of Italy (Piemonte, Toscana, Sardegna) (Crema, 1895; Lőrenthey, 1907, 1909; Bachmayer, 1953; Müller, 1984a, 1993, 1998; De Angeli & Garassino, 2006a).

Subsection Thoracotremata Guinot, 1977
Superfamily Grapsoidea MacLeay, 1838
Family Varunidae H. Milne-Edwards, 1853
Subfamily Asthenognathinae Stimpson, 1858
Genus *Asthenognathus* Stimpson, 1858

Type species: *Asthenognathus inaequipes* Stimpson, 1858.

Asthenognathus sp.
Fig. 19

Stratigraphic range: Pliocene *sensu lato*.
Type locality: Monterotondo Marittimo (Grosseto).
Material: one incomplete specimen, IGF 14637E
Desciption. Trapezoidal carapace, wider than long, convex in longitudinal section. Antero-lateral margins almost straight and aligned with the orbito-frontal part. Posterolateral reentrants well developed with slightly concave margin. The posterior margin is wide and slightly convex. Regions weakly marked. Metagastric region well marked by a deep posterior groove. Dorsal surface granulate.

Discussion. *Asthenognathus* Stimpson, 1858, includes four Recent species, *A. inaequipes* Stimpson, 1858, *A. hexagonum* Rathbun, 1909, *A. atlanticus* Monod, 1933, and "*Asthenognathus*" *gallardoi* Serène & Soh, 1976 (Ng *et al.*, 2008). The check list of the fossil species by De Angeli & Garassino (2006b) includes the following species: *A. cornishorum* Schweitzer & Feldmann, 1999 (Lower Miocene – United States), *A. globosa* (Karasawa, 1990) (= *Tritodynamia*) (Lower-Middle Miocene – Japan), *A. laverdensis* De Angeli & Garassino, 2006 (Lower Oligocene – Italy), *A. microspineus* Casadio, De Angeli, Feldmann, Garassino, Hetler, Parras & Schweitzer, 2004 (Middle Oligocene – Argentina), *A. urretae* Schweitzer & Feldmann, 2001 (Upper Oligocene – Argentina).

Fig. 19 – *Asthenognathus* sp., IGF 14637E (x 6).

The studied specimen shows morphological characters typical of *Asthenognatus* Stimpson, 1858. The lack of frontal and orbital parts do not allow a deep morphological description of this specimen. The studied specimen shows close affinities with *A. laverdensis* De Angeli & Garassino, 2006, from the Lower Oligocene of Laverda (Vicenza). However, this species has postero-lateral margins less convergent and dorsal surface smoother, with granulation limited only in the branchial regions.

Asthenognatus sp. represents the first report of this genus from the Miocene of Europe.

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Appendix

Updated list of the species of anomurans and brachyurans known to date from the Cenozoic of Tuscany (after Garassino & De Angeli, 2004; De Angeli & Garassino, 2006a).

Upper Miocene

Family Callianassidae Dana, 1852
Genus *Callianassa* Leach, 1814
Callianassa cfr. *C. subterranea* (Montagu, 1808) – Rio Popogna (Livorno)

Family Dorippidae MacLeay, 1838
Genus *Medorippe* Manning & Holthuis, 1981
Medorippe ampla Garassino, De Angeli, Gallo & Pasini, 2004 – Rio Popogna (Livorno)

Family Ethusidae Guinot, 1977
Genus *Ethusa* Roux, 1830
Ethusa popognensis n. sp. – Rio Popogna (Livorno)

Family Eriphiidae MacLeay, 1838
Genus *Eriphia* Latreille, 1817
Eriphia sp. (*in* Ristori, 1888) – San Benedetto in Val Benedetta (Livorno)

Family Goneplacidae MacLeay, 1838
Genus *Goneplax* Leach, 1814
Goneplax gulderi Bachmayer, 1953 – Rio Popogna (Livorno)

Family Potamonidae Ortmann, 1896
Genus *Potamon* Savigny, 1816
?*Potamon castellinense* (Szombathy, 1916) – Valle del Marmolaio (Livorno)

Pliocene *sensu lato*

Family Thalassinidae Latreille, 1831
Genus *Thalassina* Latreille, 1806
Thalassina sp. (*in* Ristori, 1891a) – Spicchio (Empoli – Firenze)

Family Paguridae Latreille, 1802
Genus *Pagurus* Fabricius, 1775
Pagurus squamosus Ristori, 1886 – Sarteano (Siena)

Family Diogenidae Ortmann, 1892
Genus Dardanus Paulson, 1875
Dardanus substriatus (A. Milne Edwards, 1861) – Volterra (Pisa)

Family Raninidae De Haan, 1839
Genus *Tribolocephalus* Ristori, 1886
Tribolocephalus laevis Ristori, 1886 – Orciano (Pisa)
Genus *Lysirude* Goeke, 1985
Lysirude paronae (Crema, 1895) – Cava I Sodi, Castelnuovo Berardenga-Scalo (Siena)
Genus *Raninoides* H. Milne Edwards, 1837
Raninoides pliocenicus n. sp. – Monterotondo Marittimo (Grosseto)

Family Calappidae H. Milne Edwards, 1837
Genus *Calappa* Weber, 1795
Calappa granulata (Linnaeus, 1758) – Presciano (Siena)
Calappa sp. (*in* Ristori, 1891a) – Orciano (Pisa)

Family Leucosiidae Samouelle, 1819
Genus *Ebalia* Leach, 1817
Ebalia fucinii Ristori, 1892 – Spicchio (Empoli – Firenze)
Genus *Palaeomyra* A. Milne Edwards, 1861
Palaeomyra bispinosa A. Milne Edwards, 1861 – La Strolla (Siena)

Family Portunidae Rafinesque, 1815
Genus *Portunus* Weber, 1795
Portunus edwardsi E. Sismonda, 1846 – Spicchio (Empoli – Firenze)
Portunus sp. (*in* Ristori, 1886) – Isola di Pianosa (Livorno)

Family Goneplacidae MacLeay, 1838
Genus *Chlinocephalus* Ristori, 1886
Chlinocephalus dimissiformis Ristori, 1886 – Mucigliani (Siena)
Genus *Goneplax* Leach, 1814
Goneplax rhomboides (Linnaeus, 1758) – Rapolano (Siena)
Goneplax gulderi Bachmayer, 1953 – Monterotondo Marittimo (Grosseto)
Genus *Simonellia* Vinassa de Regny, 1897
Simonellia quiricensis Vinassa de Regny, 1897 – San Quirico d'Orcia (Siena)

Family Eriphiidae MacLeay, 1838
Genus *Eriphia* Latreille, 1817
Eriphia cocchi Ristori, 1886 – Val d'Elsa (Empoli – Firenze); Montrappoli (Empoli – Firenze); Spicchio (Empoli – Firenze); Poggio all'Olio (Empoli – Firenze); Val d'Era (Pisa), Montebicchieri (Pisa), Torrita Val di Chiana (Siena); Pietrafitta (Siena); Terre Rosse (Siena).

Family Pilumnidae Samouelle, 1819
Genus *Pilumnus* Leach, 1815
Pilumnus ristorii new replacemnet name for *P. spinosus* Ristori, 1886 – Isola di Pianosa (Livorno)
Genus *Titanocarcinus* A. Milne Edwards, 1863
Titanocarcinus subovalis Ristori, 1896 – Monteroni d'Arbia (Siena)
Genus *Galenopsis* A. Milne Edwards, 1865
Galenopsis sp. (*in* Ristori, 1886) – Orciano (Pisa)

Family Xanthidae MacMeay, 1838
Genus *Monodaeus* Guinot, 1967
Monodaeus bortolottii Delle Cave, 1988 – Monterotondo Marittimo (Grosseto)

Family Varunidae H. Milne Edwards, 1858
Genus *Asthenognathus* Stimpson, 1858
Asthenognathus sp. – Monterotondo Marittimo (Grosseto)

Lower Pliocene

Family Callianissidae Dana, 1852
Genus *Callianassa* Leach, 1814
Callianassa chalmasii Brocchi, 1883 – Terre Rosse (Siena)

Family Diogenidae Ortmann, 1892
Genus *Dardanus* Paulson, 1875
Dardanus substriatus (A. Milne Edwards, 1861) – Terre Rosse (Siena), Balconevisi (San Miniato – Pisa)

Family Laomediidae Borradaile, 1903
Genus *Jaxea* Nardo, 1847
Jaxea cfr. *J. nocturna* Nardo, 1847 – Castelfiorentino (Firenze)

Family Calappidae H. Milne Edwards, 1837
Genus *Calappa* Weber, 1795
Calappa granulata (Linnaeus, 1758) – Terre Rosse (Siena)

Family Leucosiidae Samouelle, 1819
Genus *Ilia* Leach, 1817
Ilia pliocenica Ristori, 1891 – Ciuciano and Pietrafitta (Siena)
Genus *Ebalia* Leach, 1817
Ebalia cfr. *E. deshayesi* Lucas, 1846 – Poggio alla Staffa (Siena)

Family Portunidae Rafinesque, 1815
Genus *Liocarcinus* Stimpson, 1871
Liocarcinus sp. – Pietrafitta (Siena)

Family Eriphidae MacLeay, 1838
Genus *Eriphia* Latreille, 1817
Eriphia cocchii Ristori, 1886 – Balconevisi (San Miniato – Pisa), Pietrafitta (Siena), Terre Rosse (Siena)

Family Pilumnidae Samouelle, 1819
Genus *Pilumnus* Leach, 1815
Pilumnus ristorii new replacement name for *P. spinosus* Ristori, 1886 – Terre Rosse (Siena)

Upper Pliocene

Family Leucosiidae Samouelle, 1819
Genus *Ilia* Leach, 1817
Ilia pliocenica Ristori, 1891 – Spicchio (Empoli – Firenze)

Family Pilumnidae Samouelle, 1819
Genus *Titanocarcinus* A. Milne Edwards, 1863
Titanocarcinus edwardsi (E. Sismonda, 1846) – Orciano (Pisa)

Family Xanthidae MacLeay, 1838
Genus *Monodaeus* Guinot, 1967
Monodaeus bortolottii Delle Cave, 1988 – Botro dell'Alpino (Volterra – Pisa)

Plio-Pleistocene

Family Leucosiidae Samoulle, 1819
Genus *Ebalia* Leach, 1817
Ebalia cranchii Leach, 1817 – Parrana San Giusto (Livorno)
Ebalia fucinii Ristori, 1892 – Parrana San Giusto (Livorno)

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Alessandro Garassino*, Pedro Artal** & Giovanni Pasini***

Jabaloya aragonensis n. gen., n. sp. (Crustacea, Decapoda, Mecochiridae) and *Cedrillosia jurassica* n. gen., n. sp. (Crustacea, Decapoda, Glypheidae) from the Upper Jurassic of Teruel Province (Aragón, Spain)

Abstract – Decapod macrurans from the Upper Jurassic are reported from Jabaloyas and Cedrillas villages (Teruel, Aragón). The studied specimens have been ascribed to the infraorder Astacidea Latreille, 1802, including *Jabaloya aragonensis* n. gen., n. sp. (Mecochiridae Van Straelen, 1925) and *Cedrillosia jurassica* n. gen., n. sp. (Glypheidae Zittel, 1885). The new taxa enlarge the knowledge of the macruran fauna from the Jurassic of Spain.

Key words: Crustacea, Decapoda, Upper Jurassic, Spain.

Resumen – *Jabaloya aragonensis* n. gen., n. sp. (Crustacea, Decapoda, Mecochiridae) y *Cedrillosia jurassica* n. gen., n. sp. (Crustacea, Decapoda, Glypheidae) del Jurásico superior de la provincia de Teruel (Aragón, España).

Se describe un conjunto de decápodos macruros del Jurásico superior, recuperado de las poblaciones de Jabaloyas y Cedrillas, ambas en la provincia de Teruel (Aragón). Los nuevos registros se adscriben a la infraorden Astacidea Latreille, 1802 e incluyen *Jabaloya aragonensis* n. gen., n. sp. (Mecochiridae Van Straelen, 1925) y *Cedrillosia jurassica* n. gen., n. sp. (Glypheidae Zittel, 1885). Los nuevos taxones amplian el conocimiento de la escasa fauna de macruros descrita hasta ahora en el Jurásico español.

Palabras clave: Crustacea, Decapoda, Jurásico superior, España.

Riassunto – *Jabaloya aragonensis* n. gen., n. sp. (Crustacea, Decapada, Mecochiridae) e *Cedrillosia jurassica* n. gen., n. sp. (Crustacea, Decapada, Glypheidae) del Giurassico superiore della Provincia di Teruel (Aragona, Spagna).

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Vengono descritti dei crostacei decapodi del Giurassico superiore rinvenuti presso i villaggi di Jabaloyas e Cedrillas (Teruel, Aragona). Gli esemplari studiati sono stati attributi all'infraordine Astacidea Latreille, 1802 che comprende *Jabaloya aragonensis* n. gen., n. sp. (Mecochiridae Van Straelen, 1925) e *Cedrillosia jurassica* n. gen., n. sp. (Glypheidae Zittel, 1885). Questi nuovi generi approfondiscono le conoscenze della fauna a macruri del Giurassico della Spagna.

Parole chiave: Crustacea, Decapoda, Giurassico superiore, Spagna.

Introduction and geological setting

The presence of macrurans in the Jurassic of Spain is poorly mentioned in literature, and based on a single, incomplete specimen (Solé & Via, 1989). From the marine deposits of the upper Oxfordian, north to the Jabaloyas village (Province of Teruel) (Fig. 1), several specimens preserved in nodules were collected by the geologist Sixto Fernández during some field works in the 70s and were housed in the Museu Geològic del Seminari Conciliar of Barcelona. The layers consist of limestones and interbedded marly beds yielding the concretions with crustaceans, both levels being considered to belong to the Yatova Formation (Soria & Pérez, 2002). The deposits are characterized by abundant sponges within the limestones and isolated and well-preserved macrofauna in marls, mainly poriferans, and less common ammonoids and brachiopods.

A single carapace assigned here to the family Glypheidae, was recovered near the village of Cedrillas (Province of Teruel) (Fig. 1) from limestones with scarce macrofauna (mollusc remains). The marine deposits are constituted by massive micritic limestones, and corresponds to an Upper Kimmeridgian-Portlandian interval, *Everticyclammina virguliana* zone, *Retrocyclammina arrabidensis* and *chouberti* subzones (Felgueroso & Ramírez, 1971).

Previous records of Jurassic macrurans from Spain

The specimens of macrurans from the Jurassic of Spain are very rare. Dupuy & Revilla (1956) reported only one specimen of glypheids from the Upper Jurassic of Bunyol (Foia de Bunyol, Valéncia) ascribed to "*Glyphea*" *serratosai* (Museum of IGME of Madrid).
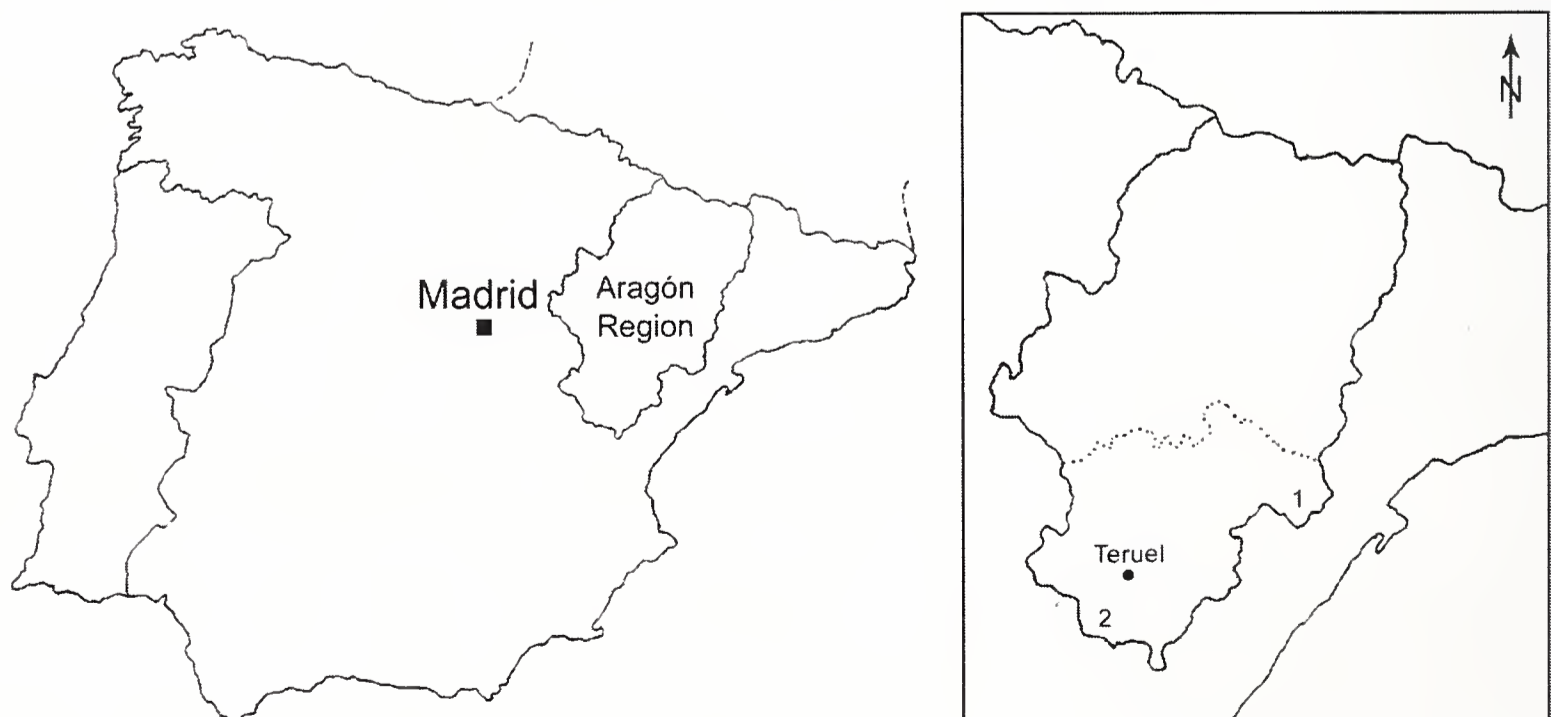
Fig. 1 – Geographic map with the fossiliferous localities. / Cartina geografica con le località fossilifere. 1) Cedrillas. 2) Jabaloyas.

Material

The studied sample includes twelve fragmentary and articulated specimens, housed in the Museu Geològic del Seminari Conciliar of Barcelona (MGSB). The specimens are three-dimensionally preserved in non calcareous nodules. Their preparation was difficult as a result of the induration of the surrounding matrix. The studied specimens are ascribed to *Jabaloya aragonensis* n. gen, n. sp. (eleven specimens) and *Cedrillosia jurassica* n. gen., n. sp. (one specimen).

Abbreviations

P1, first pereiopod; a1-a6, abdominal segments.

Systematic Palaeontology

Infraorder Astacidea Latreille, 1802
Superfamily Glypheoidea Zittel, 1885
Family Mecochiridae Van Straelen, 1925

Included fossil genera: *Mecochirus* Germar, 1827; *Meyeria* McCoy, 1849; *Pseudoglyphea* Oppel, 1862; *Huhatanka* Feldmann & West, 1978.

Genus *Jabaloya* nov.

Diagnosis: carapace subcylindrical, laterally compressed; rostrum short; anterior part of carapace with one longitudinal ridge, running medially; cervical groove deep, strongly inclined; postcervical and branchiocardiac grooves parallel strongly inclined; postcervical groove weak; branchiocardiac groove deep; hepatic groove prominent, deeply incised, strongly curved postero-ventrally; uropodal exopod with diaeresis.

Etymology: from the small village of Jabaloyas where the studied specimens were discovered.

Type species: *Jabaloya aragonensis* n. sp.

Description: as for the type species.

Discussion. At present Mecochiridae includes four fossil genera from the Upper Triassic to Upper Cretaceous. As argued by Förster (1978), Feldmann & West (1978) and Feldmann *et al.* (1995), orientation and relative development of the main carapace grooves, carapace and abdominal ornamentations, and length of P1 are the useful morphological characters for the identification of each genus. Therefore, *Jabaloya* n. gen. cannot be assigned to four mecochirid genera (Fig. 2). Even though the orientation and development of the main carapace grooves and a strongly reduced gastric region share *Jabolaya* n. gen. with *Mecochirus* Germar, 1827, and *Meyeria* McCoy, 1849, the prominent, postero-ventrally, strongly curved hepatic groove, and the presence of only one median longitudinal ridge cutting in two equal parts the gastric region distinguish the new genus from the others. Different is instead the orientation of the main carapace grooves between *Jabaloya* n. gen. and *Pseudoglyphea* Oppel, 1862. Moreover, the development of the gastric region is different: reduced in the new genus and wide in *Pseudoglyphea*. Finally, the absence of branchiocardiac groove and a wide gastric region distinguish *Huhatanka* Feldmann & West, 1978, from the new genus.
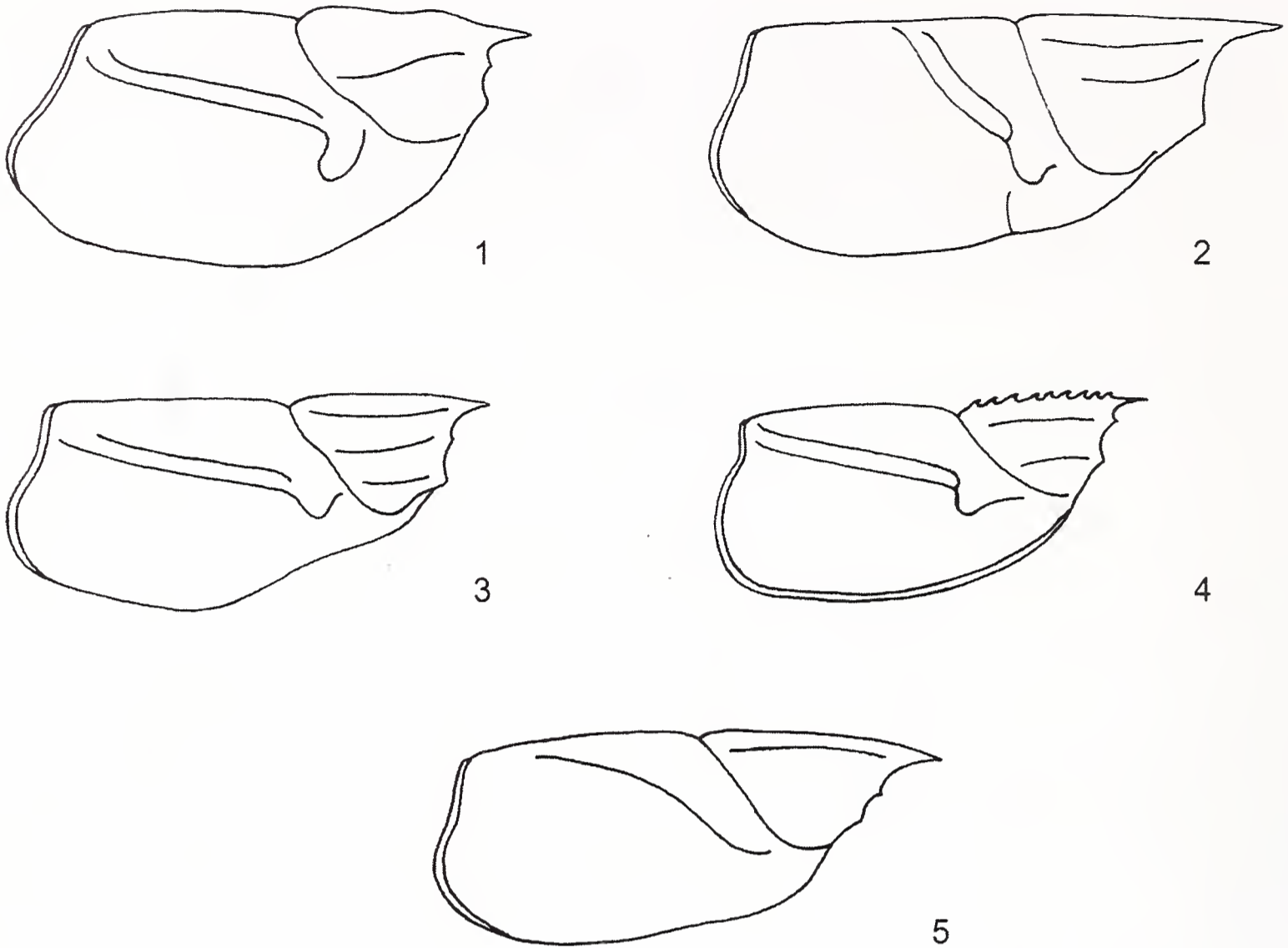
Fig. 2 – Comparison among the carapaces of the genera belonging to Mecochiridae and the carapace of the new genus. / Confronto tra i carapaci dei generi della famiglia Mecochiridae e il carapace del nuovo genere. 1) *Jabaloya* n. gen. 2) *Pseudoglyphea* Oppel, 1862. 3) *Mecochirus* Germar, 1827. 4) *Meyeria* McCoy, 1849. 5) *Huhatanka* Feldmann & West, 1978. Out of scale.

Jabaloya aragonensis n. sp.
Figs. 2-6

Diagnosis: as for the genus.

Etymology: the trivial name alludes to Aragón Region where the studied specimens were discovered.

Holotype: MGSB 74517.

Paratypes: MGSB 56544 a, b.

Type locality: Jabaloyas (Teruel, Aragón).

Geological age: Upper Jurassic (upper Oxfordian).

Material and measurements: eleven fragmentary and articulate specimens in lateral view; length of carapace between 30 and 40 mm. MGSB 56554 a, b, c, d, e, f, g, h, i, 56555 a-b (part and counter-part), 74517. Thoracic and abdominal appendages not preserved.

Description: medium-sized mecochirid with exoskeleton strongly tuberculate.

Carapace. Carapace with dorsal margin nearly inflated. Posterior margin with a sigmoid curve produced near posteroventral termination. Posteroventral margin strongly curved. Anteroventral margin inflated, inclined from anterior termination ventrally to near posterior termination of cephalic region where it curves strongly ventrally to join posteroventral margin. Anterior margin almost vertical. Rostrum short, smooth. Cervical groove slightly sinuous, strongly inclined, intercepting dorsal surface at an

angle of about 50° at a distance one third of total length of dorsal margin from anterior. Branchiocardiac groove strongly inclined, approaching dorsal surface at an angle of about 20° and then curving slightly dorsally to intersect the dorsal surface at an angle of about 25°. Postcervical groove strongly inclined, parallel to branchiocardiac groove for its all length. Hepatic groove prominent, strongly curved postero-ventrally. Cervical, branchiocardiac, and hepatic grooves deep, narrow, well marked. Postcervical groove weak. Cephalic region ornamented by one tuberculate lateral ridge running medially, dividing the gastric region in two equal parts. All regions ornamented by deep pits. Gastric region strongly reduced for the strong inclination of cervical groove.

Abdomen. Abdomen well developed. a1 reduced, about half as long as a2. a2 about one third longer than a3 through a5 which are of about equal length. a6 longer than the others. Tergal regions of all segments smooth, generally subrectangular, bounded on lateral sides by two deep grooves. Pleura of a2-5 strongly developed, highly ornamented. Major surface of pleura tuberculate. Ventral and lateral margins finely punctuate. Pleura of a2-5 triangular with a small spine developed on termination. Pleuron of a6 strongly triangular, pointed with smooth ventral and lateral margins. Telson subrectangular, smooth. Uropodal endopod with a median longitudinal ridge well developed for all its length. Uropodal exopod with well developed median longitudinal ridge, external margin bordered by a row of well-developed spines, the last two distal spines longer than the others. Upper margin of rounded diaeresis finely serrate with central spine longer than the lateral ones.

Cephalic appendages. Preserved only the small eye and the first article of the antennulae.
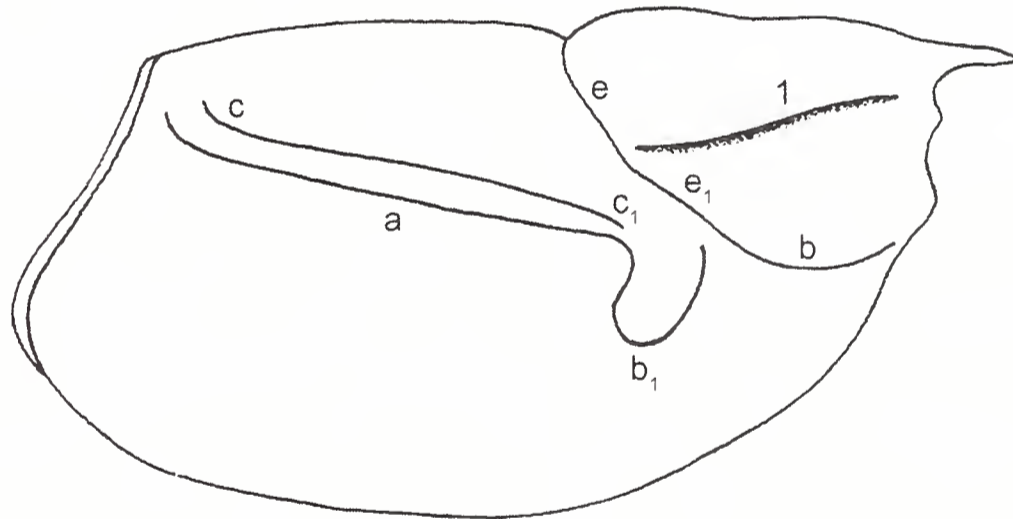
Fig. 3 – *Jabaloya aragonensis* n. gen., n. sp., carapace. 1) antennal ridge / carena antennale. a) branchiocardiac groove / solco branchiocardiaco. b) antennal groove / solco antennale. b_1) hepatic groove / solco epatico. c-c_1) postcervical groove / solco postcervicale. e-e_1) cervical groove / solco cervicale.

Fig. 4 – *Jabaloya aragonensis* n. gen., n. sp., incomplete reconstruction / ricostruzione incompleta.

Fig. 5 – *Jabaloya aragonensis* n. gen., n. sp., holotype / olotipo, MGSB 74517 (x 2.5).

Fig. 6 – *Jabaloya aragonensis* n. gen., n. sp., paratype / paratipo, MGSB 56554 c (x 3.3).

Family Glypheidae Zittel, 1885

Included fossil genera: *Glyphea* v. Meyer, 1835; *Litogaster* v. Meyer, 1844; *Trachysoma* Bell, 1858; *Squamosoglyphea* Beurlen, 1930; *Paralitogaster* Glaessner, 1969.

Genus *Cedrillosia* nov.

Diagnosis: carapace subcylindrical, laterally compressed; rostrum short; antennal region with one longitudinal ridge, running parallel to the anteroventral margin; cervical groove deep, steeply inclined; postcervical groove sinuous, reduced, divergent to branchiocardiac groove; branchiocardiac groove deep, having a curved V-shaped bifurcation extending in the cardiac region, directed forwards; inferior groove almost straight, deeply impressed; gastro-orbital groove curved, bifurcated, delimiting two raised lobes.

Etymology: from the small village of Cedrillas where the studied specimens were discovered.

Type species: *Cedrillosia jurassica* n. gen., n. sp.

Description: as for the type species.

Discussion. At present Glypheidae includes five fossil genera and the Recent *Neoglyphea* Forest & de Saint Laurent, 1975, and *Laurentaeglyphea* Forest, 2006. Among the fossil genera, there was particular confusion regards the identification of *Glyphea* v. Meyer, 1835, and *Trachysoma* Bell, 1858. In fact Quayle (1987)
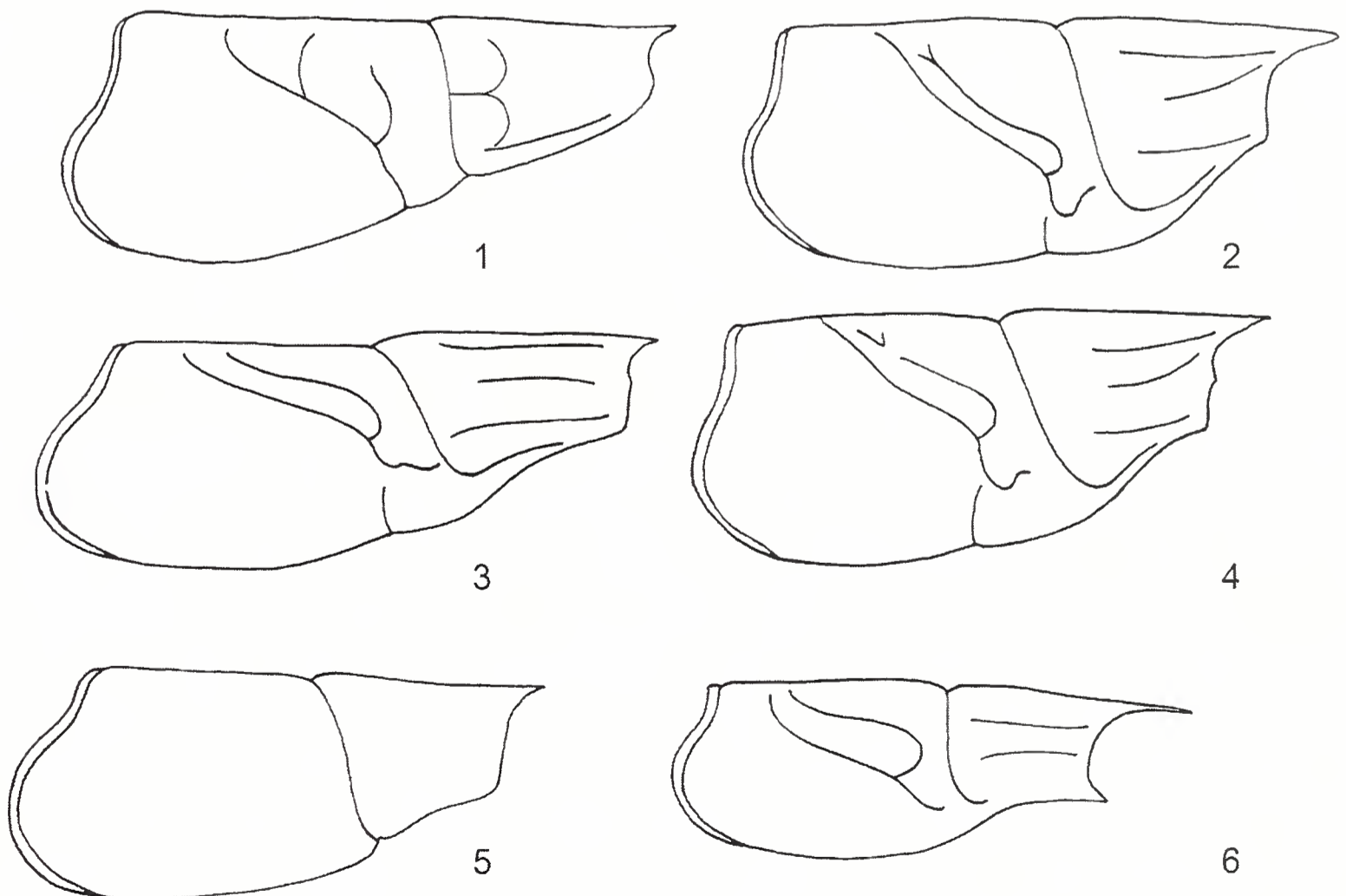
Fig. 7 – Comparison among the carapaces of the genera belonging to Glypheidae and the carapace of the new genus / Confronto tra i carapaci dei generi della famiglia Glypheidae e il carapace del nuovo genere. 1) *Cedrillosia* n. gen. 2) *Paralitogaster* Glaessner, 1969. 3) *Glyphea* v. Meyer, 1835. 4) *Litogaster* v. Meyer, 1844. 5) *Squamosoglyphea* Beurlen, 1930. 6) *Trachysoma* Bell, 1858. Out of scale.

considered the latter, as junior synonym of *Glyphea*. However, if we consider the orientation and relative development of the main carapace grooves as diagnostic characters to distinguish the genera of Glypheidae (Feldmann & de Saint Laurent, 2002), we must consider distinct these two genera. In fact, *Paralitogaster* Glaessner, 1969, *Litogaster* v. Meyer, 1844, and *Trachysoma* Bell, 1858, have parallel postcervical and branchiocardiac grooves, while both grooves converge posteriorly, and the postcervical groove is incompletly developed in *Glyphea* v. Meyer, 1835. The postcervical and branchiocardiac grooves are instead absent in *Squamosoglyphea* Beurlen, 1930.

If we consider valid this method to distinguish the genera of Glypheidae, the orientation and relative development of the main carapace grooves of the studied specimen do not resemble any of the above-mentioned genera for the reduced postcervical groove, not parallel to branchiocardiac groove and for the branchiocardiac groove having a V-shaped bifurcation in the cardiac region, peculiar character of the new genus (Fig. 8). Among the genera of Glypheidae, the V-shaped bifurcation of branchiocadiac groove is also present in *Glyphea*. In fact, it is the only genus in which some species such as *G. bathonica* de Ferry, 1865, *G. muensteri* (Voltz) *in* v. Meyer, 1840, *G. regleyana* Desmarest, 1822, *G. yoshiakii* Kato & Karasawa 2006, show this character. However, a deepened analysis reveals that the V-shaped bifurcation of the branchiocardiac groove directed forwards or backwards, is in reality an extension of postcervical groove, connected to the branchiocardiac groove by a thin unnamed groove. In the new genus, the branchiocardiac groove has a true lateral branch, extending in the cardiac region without joining to the postcervical groove. Since *Glyphea* has never been the subject of a deepened review, we could suppose the existence of two different groups of glypheids, with or without the connection between postcervical and branchiocardiac grooves. For the moment this real V-shaped bifurcation of the branchiocardiac groove, peculiar of *Cedrillosia* n. gen., is not present in any genus belonging to Astacidea.

Cedrillosia jurassica n. sp.
Figs. 7-9

Diagnosis: as for the genus.

Etymology: the trivial name alludes to the Jurassic, geological period of the studied specimen.

Holotype: MGSB 24780.

Type locality: Cedrillas (Teruel, Aragón).

Geological age: Upper Jurassic (upper Kimmeridgian-Portlandian).

Material and measurement: one complete carapace in lateral view, 30 mm long. MGSB 24780. Abdomen, cephalic and thoracic appendages not preserved.

Description: carapace with dorsal margin nearly straight. Posterior margin sigmoid, produced near posteroventral termination. Posteroventral margin gently curved. Anteroventral margin nearly straight, inclined from anterior termination ventrally to near posterior termination of cephalic region where it curves slightly ventrally to join posteroventral margin. Anterior margin almost vertical. Rostrum short, smooth. Cervical groove slightly sinuous, steeply inclined, intercepting dorsal surface at an angle of about 80° at a distance one third of total length of dorsal margin from anterior. Branchiocardiac groove oblique, approaching dorsal

surface at an angle of about 40° and then curving slightly dorsally to intersect dorsal surface at an angle of about 50°. Branchiocardiac groove having curved V-shaped bifurcation directed forwards and extending in the cardiac region. Distal part of branchiocardiac groove and lateral branch delimiting a triangular-shaped, smooth raised lobe. Postcervical groove reduced divergent to branchiocardiac groove for its all length, diverging abruptly from it ventrally to a point near the middle of carapace where it curves slightly ventrally and posteriorly to join branchiocardiac groove. Proximal part of branchiocardiac and postcervical grooves delimiting a subtriangular-shaped, smooth raised lobe. Postcervical groove then slightly curving anteriorly where it intersects almost straight inferior groove and joining ventral margin. Gastro-orbital groove curved, bifurcated, delimiting two curved raised lobes close to cervical groove. All grooves deep, narrow, well marked. Antennal region ornamented by one tuberculate lateral ridge running parallel to anteroventral. Branchial region ornamented with deep pits. Gastric, antennal, cardiac, hepatic, and pterigostomial regions ornamented with weak pits.
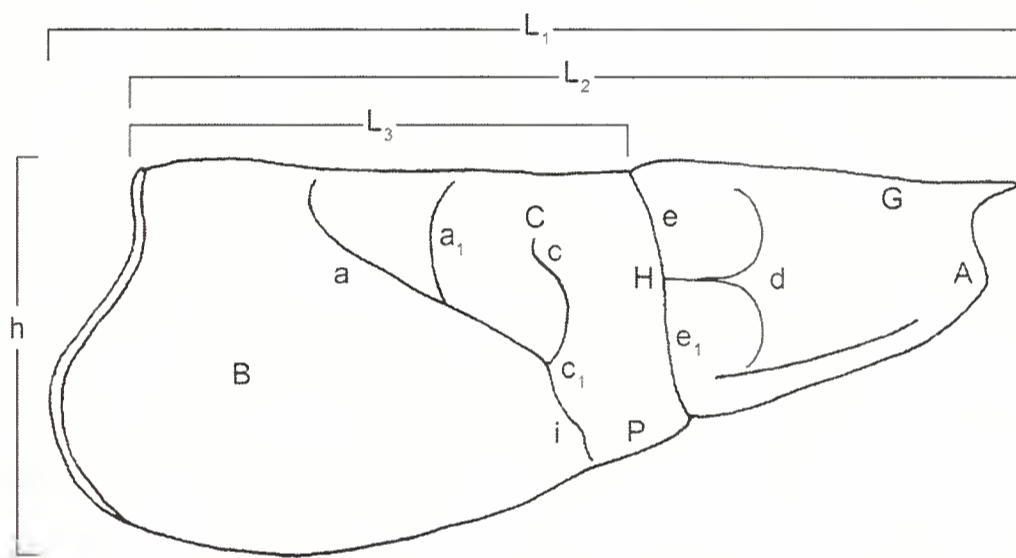
Fig. 8 – *Cedrillosia jurassica* n. gen., n. sp. L1: 30 mm. L2: 27 mm. L3: 17 mm. h: 10 mm. A) antennal region / regione antennale. B) branchial region / regione branchiale. C) cardiac region / regione cardiaca. G) gastric region / regione gastrica. H) hepatic region / regione epatica. P) pterigostomial region / regione pterigostomiale. a) branchiocardiac groove / solco branchiocardiaco. a_1) accessory branch of branchiocardiac groove / ramificazione laterale del solco branchiocardiaco. c-c_1) postcervical groove / solco postcervicale. d) gastro-orbital groove / solco gastro-orbitale. e-e_1) cervical groove / solco cervicale. i) lower groove / solco inferiore.

Fig. 9 – *Cedrillosia jurassica* n. gen., n. sp., holotype / olotipo, MGSB 24780 (x 3).

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Alessandro Garassino*, Pedro Artal** & Giovanni Pasini***

New report of decapod macrurans from the Eocene of Catalonia and Aragón (Spain)

Abstract - The recent discovery of new macrurans from Catalonia, Sant Hipòlit de Voltregà (Barcelona) and from Aragón Region, Serraduy del Pon, Arén, and Belsué (Huesca) increases the carcinologic knowledge from the Eocene of Spain. They are *Enoploclytia eocenica* n. sp. (Erymidae Van Straelen, 1924) and nephropid remains (Nephropidae Dana, 1852 *sensu* Tshudy and Babcock, 1997). The report of *Enoploclytia* McCoy, 1849, extends the geographic and geologic range for the genus to Europe.

Key words: Crustacea, Decapoda, Eocene, Spain.

Resumen - Nuevos registros de decápodos macruros del Eoceno de Cataluña y Aragón (España).

La recuperación de nuevos decápodos macruros en Cataluña (Sant Hipòlit de Voltregà, Provincia de Barcelona), y en la región de Aragón, Serraduy del Pon, Arén y Belsué (Provincia de Huesca), amplía el conocimiento carcinológico del Eoceno de España. Los macruros estudiados se ascriben a la infraorden Astacidea Latreille, 1802, con el registro de Enoploclytia eocenica n. sp. (Erymidae Van Straelen, 1924), y a la Familia Nephropidae Dana, 1852 (sensu Tshudy and Babcock, 1997). El registro de Enoploclytia McCoy, 1849, amplía la distribución estratigráfica de este género en el Eoceno, conocido tan sólo por una especie en los Estados Unidos. El registro de un nephrópido indeterminado, amplía la distribución estratigráfica y paleogeográfica de la familia.

Palabras clave: Crustacea, Decapoda, Eoceno, España.

Riassunto - Nuova segnalazione di decapodi macruri dell'Eocene della Catalonia e Aragona (Spagna).

La recente scoperta di nuovi macruri in Catalonia, Sant Hipòlit de Voltregà (Barcellona) e nella Regione dell'Aragona, Serraduy del Pon, Arén, e Belsué (Huesca) incrementa le conoscenze carcinologiche dell'Eocene della Spagna. Gli esemplari studiati sono stati attribuiti a *Enoploclytia eocenica* n. sp. (Erymidae Van Straelen, 1924) e a resti indeterminati di nefropide. (Nephropidae Dana, 1852 *sensu* Tshudy and Babcock, 1997). La scoperta di *Enoploclytia* McCoy, 1849, estende la distribuzione geografica e geologica di questo genere in Europa.

Parole chiave: Crustacea, Decapoda, Eocene, Spagna.

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Introduction and geological setting

The decapod macrurans assigned here to the genus *Enoploclytia* McCoy, 1849, were circumstantially recovered from Eocene marine deposits during last years and posteriorly housed in the Museu Geològic del Seminari of Barcelona (MGSB). The marine sediments at the type locality are situated about 7 km northwest from the village of Sant Hipòlit de Voltregà (Barcelona Province, Catalonia) (Fig. 1). Deposits are mainly constituted by marls very rich in macrofauna, such as sponges, bryozoans, the echinoids *Coelopleurus* and *Schizaster*, and the brachyuran *Harpactocarcinus punctulatus*. The age is considered to be Bartonian (Middle Eocene), and the local environment is described as a shallow shelf (see Serra-Kiel *et al.*, 2003). Some remains, nearly complete claws and isolated pereiopods, were collected from Eocene layers near the villages of Arén and Serraduy del Pon (Huesca Province, Aragón). The strata correspond to the Tremp-Graus basin, being confirmed as Ilerdian (lowermost Eocene) in age (see Serra-Kiel *et al.*, 1994), and are related to not far reefal mounds, which are widely distributed along the basin (see Artal & Castillo, 2005). The associated macrofauna is characterized by the presence of large echinoids (*Linthia, Eupatagus, Amblipygus* and *Schizaster*), very common in the Ilerdian strata of the area.

A single carapace assigned in this study to Nephropidae Dana, 1852, was recovered about 2 km southeast from the village of Belsué (Huesca Province, Aragón) (Fig.1). The marine deposits from which the decapod macruran was collected correspond to the Margas de Arguís-Pamplona Formation (Puigdefábregas, 1975) and are considered to be Priabonian (Upper Eocene) in age. The local biofacies is characterized by the dominant presence of the brachyuran *Harpactocarcinus punctulatus* and some not well preserved molluscs. The local associated macrofauna, the lithology, marls somewhat sandy, and the location within the basin suggest not extremely deep environmental conditions, probably the photic zone of a shelf facies.
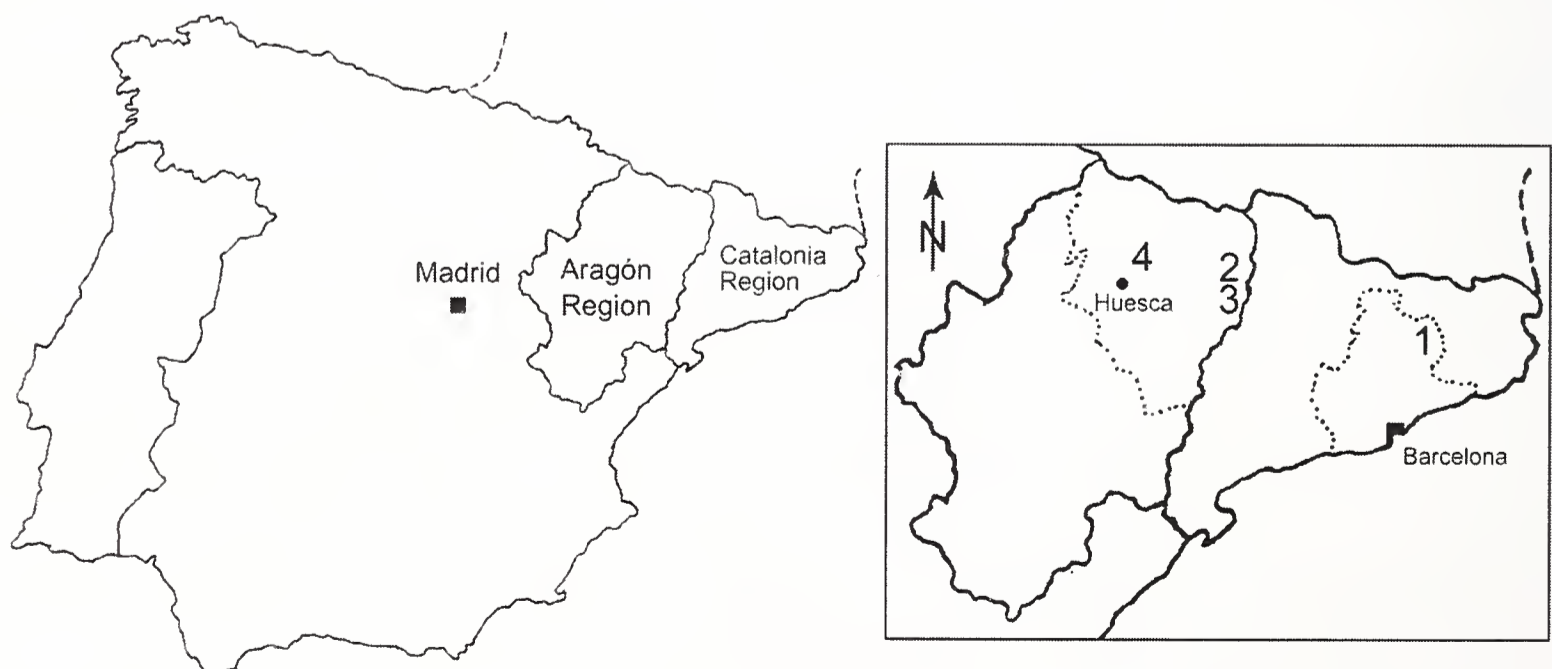
Fig. 1 – Geographic map with the fossiliferous localities / cartina geografica con le località fossilifere. 1) Sant Hipòlit de Voltregà. 2) Serraduy del Pon. 3) Arén. 4) Belsué.

Material

The studied sample includes five fragmentary and articulate specimens, housed in the Museu Geològic del Seminari Conciliar of Barcelona (MGSB). The specimens are preserved three-dimensionally and their preparation was difficult for their fragility and the hardness of the surrounding rock. The studied specimens are ascribed to *Enoploclytia* McCoy, 1849, with *E. eocenica* n. sp. (4 specimens). Moreover, one incomplete specimen is ascribed to Nephropidae with genus and species indeterminate.

Abbreviations

P1, first pereiopod
Measurements are given in millimetres (mm).

Systematic Palaeontology

Infraorder Astacidea Latreille, 1802
Family Erymidae Van Straelen, 1924
Genus *Enoploclytia* McCoy, 1849

Type species: *Astacus leachii* Mantell, 1822, by monotypy.

Included fossil species: *E. leachii* (Mantell, 1822); *E. dixoni* (Bell, 1850); *E. heterodon* Schlüter, 1862; *E. paucispina* Schlüter, 1868; *E. plauensis* (Geinitz, 1875); *E. granulicauda* Schlüter, 1879; *E. walkeri* (Whitfield, 1883); *E. minor* Woodward, 1900; *E. sculpta* Rathbun, 1926; *E. dorsetensis* Woods, 1927; *E. seitzi* Glaessner, 1932; *E. gardnerae* (Rathbun, 1935); *E. kimzeyi* (Rathbun, 1935); ?*E. selmaensis* (Rathbun, 1935); *E. tumimanus* Rathbun, 1935; *E. glaessneri* Van Straelen, 1936; *E. triglypta* Stenzel, 1945; *E. wintoni* Stenzel, 1945; *E. tenuidigitata* Woods, 1957; *E. collignoni* Secretan, 1964; *E. armata* Secretan, 1964; *E. porteri* Miller & Ash, 1988.

Enoploclytia eocenica n. sp.
Figs. 2-4

Diagnosis: carapace subcylindric; rostrum short, spineless dorsally and ventrally; regions of carapace inflated; cervical, postcervical, and branchiocardiac grooves deep, wide; hepatic groove shallow, narrow; branchiocardiac groove reduced; stocky chela of P1 having three strong teeth on inner lateral margin and two strong teeth on outer lateral margin.

Etymology: the trivial name alludes to Eocene, geological period of the studied specimens.

Holotype: MGSB 58902.

Paratype: MGSB 74526.

Geological age: Middle Eocene (Bartonian).

Type locality: Sant Hipòlit de Voltregà (Barcelona, Catalonia).

Material and measurements: one complete carapace and three articulate chelae.
MGSB 58902 – length of carapace: 88
MGSB 74526 – length of the chela: 74
MGSB 58902, 74520, 74526 (part and counter-part), 74527

Even though the type locality is Sant Hipòlit de Voltregà, the studied specimens come from different localities, as follows:

Sant Hipòlit de Voltregà (Barcelona, Catalonia): MGSB 58902, 74520

Serraduy del Pon (Huesca, Aragón): MGSB 74526

Arén (Huesca, Aragón): MGSB 74527

Abdomen, cephalic and abdominal appendages not preserved.

Description. Large-sized erymid with exoskeleton and P1 strongly tuberculate.

Carapace. Carapace subcylindric with strongly ashlar dorsal margin. Posterior margin slightly sigmoid, produced near posteroventral termination. Posteroventral margin strongly curved. Anteroventral margin inflated and inclined from anterior termination ventrally to near posterior termination of cephalic region where it curves slightly ventrally to join posteroventral margin. Anterior margin almost vertical. Rostrum short, spineless ventrally and dorsally. Cervical groove straight, slightly inclined, intercepting dorsal surface at an angle of about 70° at a distance one third of total length of dorsal margin from anterior. Branchiocardiac groove slightly inclined, reduced, approaching dorsal surface at an angle of about 60°. Postcervical groove slightly inclined, parallel to branchiocardiac groove for its all length. Hepatic groove prominent, slightly curved postero-ventrally. Cervical, postcervical, and branchiocardiac grooves deep, wide. Hepatic groove shallow, narrow. Branchial region strongly expanded. All regions ornamented by large tubercles.

Thoracic appendages. P1 with stocky chela preserved as inner face. Enlarged propodus with three strong teeth on inner lateral margin and two strong teeth on outer lateral margin. Movable and finger fingers slightly curved distally. Carpus subrectangular and short. Surface of chela and carpus strongly tuberculate.

Discussion. As reported by Secretan (1964), *Enoploclytia* is characterized by possession of carapace with well developed rostrum and branchial region strongly expanded, deep and wide cervical groove, postcervical groove most important than the cervical groove but narrowed downwards, branchiocardiac groove reduced, pereiopod 1 with stocky chelae, strongly tuberculate carapace and P1.

The most part of these morphological characters are visible on the studied specimens that are ascribed to this genus.

At present, *Enoploclytia* has known from the Triassic to the Paleocene in Central and Northern Europe (Schlüter, 1862, 1879; Fritsch & Kafka, 1887; Glaessner, 1933; Van Straelen, 1936; Mertin, 1941; Förster, 1966), Great Britain (Mantell,
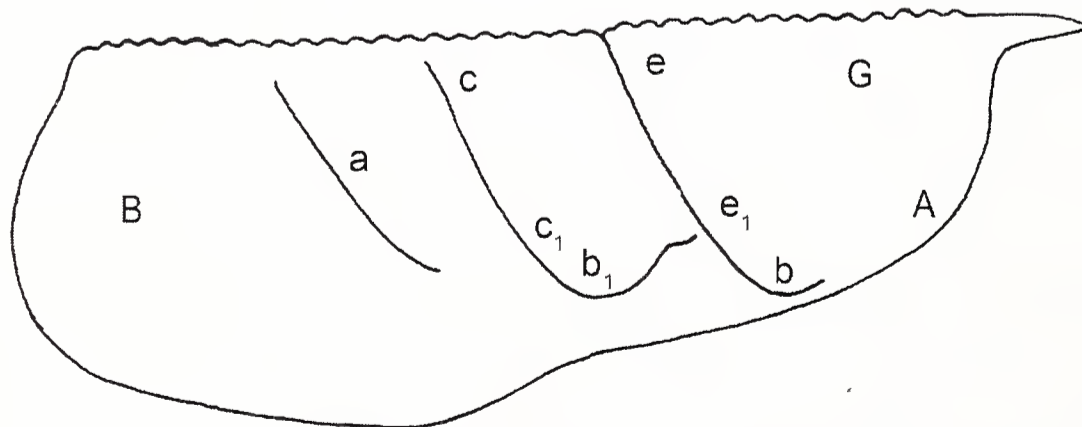
Fig. 2 – *Enoploclytia eocenica* n. sp., carapace. A) antennal region / regione antennale. B) branchial region / regione branchiale. G) gastric region / regione gastrica. a) branchiocardiac groove / solco branchiocardiaco. b) antennal groove / solco antennale. b_1) hepatic groove / solco epatico. c-c_1) postcervical groove / solco postcervicale. e-e_1) cervical groove / solco cervicale.

Fig. 3 – *Enoploclytia eocenica* n. sp., holotype / olotipo, MGSB 58902 (x 0.7).

Fig. 4 – *Enoploclytia eocenica* n. sp., MGSB 74526, chela of P1, inner face / chela del P1, faccia interna (x 1.3).

1822; McCoy, 1849; Woods, 1930), Niger (Joleaud & Hsu, 1935), Madagascar (Secretan, 1964), N America (Rathbun, 1935; Stenzel, 1945; Beirich & Feldmann, 1980; Miller & Ash, 1988), S America (Aguirre-Urreta, 1989; Vega, 2005, Vega *et al.*, 2007), and Australia (Woods, 1957; Hill *et al.*, 1968). Much discussed is the belonging of *E. porteri* from the Triassic of Arizona (Miller & Ash, 1988) to this genus. In fact, Aguirre Urreta (1989) pointed out that the diminutive and smooth specimen can hardly be placed in *Enoploclytia* or even in the Erymidae. It could be probably a true fresh-water crayfish, related to the Northern Hemisphere Astacidae or Cabaridae and allied forms. Moreover, it is much discussed the record of *Enoploclytia* in the Eocene. In fact, ?*E. selmaensis* (Rathbun, 1935) is reported in dubitative form from the Eocene of North America (Feldmann, 1981). The poor preservation of this species did not allow a comparison with the new species.

So *Enoploclytia eocenica* n. sp. represents the only testified and most complete species from the Eocene, enlarging the stratigraphic range of the genus.

Family Nephropidae Dana, 1852 *sensu* Tshudy and Babcock, 1997

Genus and species indeterminate
Fig. 5

Locality: Belsué (Huesca, Aragón).
Geological age: Upper Eocene (Priabonian).
Material: one fragmentary specimen. MGSB 74523
Discussion. Even though the studied specimen is fragmentary it is ascribed to Nephropidae for the presence of two strongly raised lateral ridges in the posterior portion of carapace and one median ridge interrupted proximally by a deep cervical groove. In fact the presence of impressive ridges in the posterior portion of carapace is a typical character of some living and fossil genera of Nephropidae, like *Nephropsis* Wood-Mason, 1873, *Metanephrops* Jenkins, 1972, *Nephrops* Leach, 1814, *Lissocardia* v. Meyer, 1851, and *Palaeonephrops* Mertin, 1941.

Fig. 5 – Nephropidae, genus and species indeterminate / nefropide, genere e specie indeterminate, MGSB 74523, posterior part of carapace / parte posteriore del carapace (x 5.7).

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A new hermit crab (Crustacea, Anomura, Paguroidea) from the Late Cretaceous (Cenomanian) of Lebanon

Abstract - A hermit crab from the Late Cretaceous (Cenomanian) is reported for the first time from Lebanon. The studied specimen has been ascribed to the superfamily Paguroidea Latreille, 1802, including *Striadiogenes frigerioi* n. gen., n. sp. (Diogenidae Ortmann, 1892). The discovery of *S. frigerioi* is very important because it is the first record of a hermit crab from the Late Cretaceous of Lebanon but, particularly, it represents the first complete fossil paguroid described to date, increasing substantially the knowledge of the poorly recorded Mesozoic forms of this superfamily.

Key words: Decapoda, Anomura, Paguroidea, Late Cretaceous, Lebanon.

Riassunto - Un nuovo paguro (Crustacea, Anomura, Paguroidea) del Cretacico superiore (Cenomaniano) del Libano.

Viene descritto un paguride del Cretacico superiore (Cenomaniano) del Libano. L'esemplare studiato è stato ascritto alla superfamiglia Paguroidea Latreille, 1802 che comprende *Striadiogenes frigerioi* n. gen., n. sp. (Diogenidae Ortmann, 1892). La scoperta di *S. frigerioi* è molto importante in quanto è la prima segnalazione di un paguride nel Cretacico superiore del Libano e, in particolare, rappresenta il primo paguroide completo sinora descritto, incrementando notevolmente le conoscenze sulle forme Mesozoiche di questa superfamiglia, scarsamente documentate.

Parole chiave: Decapoda, Anomura, Paguroidea, Cretacico superiore, Libano.

Geological setting

The sublithographic limestones of Lebanon are well known for their rich and well preserved fossil assemblage ("Konservat-Lagerstätten") of the famous "fish-beds" layers, including vertebrates and invertebrates remains (particularly decapod crustaceans), from different localities as Haqel, Hadjula, Maifouk, Al-Namoura, and Sahel-Alma.

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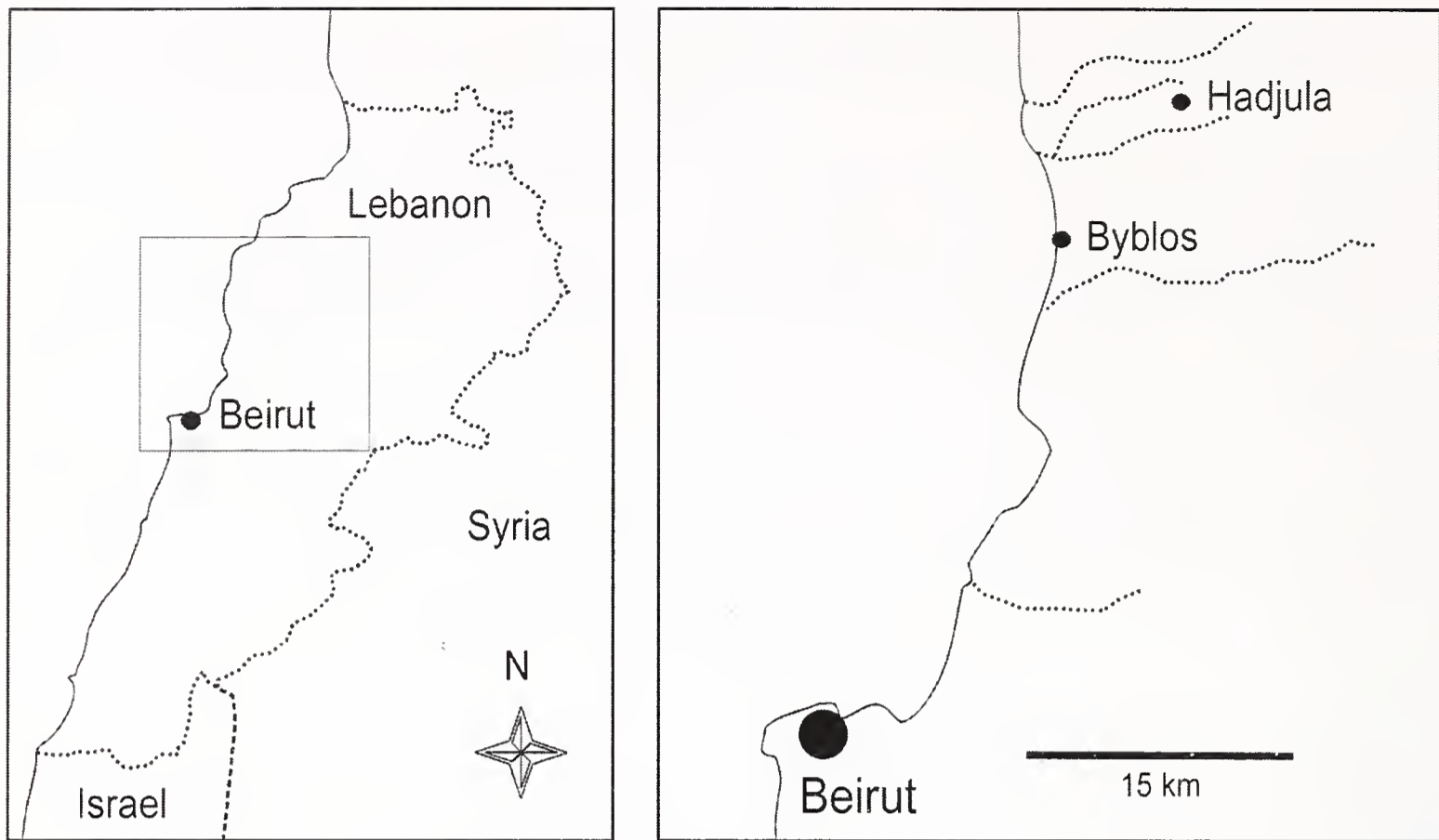
Fig. 1 – Geographic map with fossiliferous locality (after Fucks, 2006) / Carta geografica con la località fossilifera (elaborata da Fucks, 2006).

In the last 150 years many decapod species were reported and revised by various authors (Brocchi, 1875; Fraas, 1878; Dames, 1886; Whiters, 1928; Glaessner, 1945; Roger, 1946; Förster, 1984; Garassino, 1994, 2001; Larghi, 2004; Garassino & Schweigert , 2006).

Hadjula village is located about 10 km NE of Byblos, on the geographic ridges running parallel to the Mediterranean Sea coast, where the Late Cretaceous strata crop out (Fig. 1).

The biostratigraphical studies by Dubertret (1959, 1966), Hückel (1969, 1970, 1974a, 1974b) and Saint Marc (1974) placed the sequences at Haqel, Hadjula, and Maifouk at the early-middle Cenomanian boundary. According to Hemleben (1977), Haqel and Hadjula are younger. In fact, the author dated these quarries to the late Cenomanian. Recently, Dalla Vecchia *et al.* (2002) considered the Hadjula assemblages to be lower late Cenomanian in age. On the basis of these data, we assigned our specimen to the late Cenomanian in generic terms (Late Cretaceous).

Previous records of Diogenidae from the Cretaceous

The studied specimen has been assigned to the Diogenidae Ortmann, 1892, in the infraorder Anomura MacLeay, 1838. The fossil record of Diogenidae in the Late Cretaceous is poorly documented and consists only of a few fragmentary or incomplete specimens from Europe, United States, and Antarctica Peninsula (indeterminate species not considered).

Rathbun (1935) reported *Paguristes* Dana, 1851, with *P. onachitensis* Rathbun, 1935 (one poorly preserved specimen) from the late Campanian of Arkansas (United States). Bishop (1983) reported *Paguristes* with *P. whitteni* Bishop, 1983 (25 chelipeds) from the early Maastrichtian of Mississippi (United States). Bishop (1986) placed *P. whitteni* (30 chelipeds) within a new genus *Parapaguristes* toge-

ther with a new species *P. tuberculatus* (4 chelipeds) from the middle Maastrichtian from Mississippi (United States). Feldmann *et al.* (1993) and Olivero & Aguirre-Urreta (1994) rejected Bishop's view.

Feldmann *et al.* (1993) reported *Paguristes santamartaensis* (2 chelipeds) from the ?late Santonian-middle Campanian of Antarctica.

Collins *et al.* (1995) reported *Paguristes* with *P. florae* Collins, Fraaye & Jagt, 1995 (10 incomplete chelipeds) from the Maastrichtian of The Netherlands. Fraaije *et al.* (2008) described the new genus *Annuntidiogenes* with *A. ruizdegaonai* Fraaije, van Bakel, Jagt & Artal, 2008 (one incomplete carapace) from the late Albian of Monte Orobe (Navarra, Spain) and *A. sunuciorum* Fraaije, van Bakel, Jagt & Artal, 2008 (one incomplete specimen *in situ*) from the Maastrichtian of The Netherlands. Finally Fraaije *et al.* (2009) reported a new coeval species of the same genus, *A. worfi* Fraaije, van Bakel, Jagt, Klompmaker & Artal, 2009 (one incomplete carapace), from the late Albian of Alsasua area (Navarra, Spain) only few kilometres south of Monte Orobe.

Material

One complete and articulated specimen in dorsal view (part and counter-part), with the soft body, exceptionally well preserved. It is compressed dorso-ventrally and flattened on the surface of the matrix.

The studied specimen was also investigated by UV light, to point out detailed phosphatised parts and soft tissues. The preparation was made by air gravers due to the hard nature of the surrounding rock. The perfect preservation allowed also a detailed reconstruction of the complete specimen. The studied specimen has been ascribed to the infraorder Anomura MacLeay, 1838, including *Striadiogenes frigerioi* n. gen., n. sp. (Diogenidae Ortmann, 1892). The carapace terminology used in this systematic description follows the scheme proposed by Forest *et al.* (2000) and Fraaije *et al.* (2008).

The specimen is housed in the Palaeontological Collections of the Museo di Storia Naturale, Milano (MSNM).

Abbreviations

P1-P4, first to fourth pereiopods.
Measurements are given in millimetres (mm).

Systematic Palaeontology

Order Decapoda Latreille, 1802
Infraorder Anomura MacLeay, 1838
Superfamily Paguroidea Latreille, 1802
Family Diogenidae Ortmann, 1892

Included fossil genera: *Annuntidiogenes* Fraaije, van Bakel, Jagt & Artal, 2008 (late Albian – Spain; Maastrichtian – The Netherlands); *Calcinus* Dana, 1851 (Lutetian – Italy; Pliocene – Italy); *Ciliopagurus* Forest, 1995 (Oligocene – Belgium; Badenian – Hungary); ?*Clibanarius* Dana, 1852 (?Late Eocene – Egypt); *Dardanus* Paulson, 1875 (Eocene – United States and Egypt; Oligocene – Asia; Lutetian – Italy; Miocene – Europe; Pliocene – Italy and Fiji; Pleistocene – United States); *Diogenes* Dana, 1851 (Ypresian – Italy); *Eocalcinus* Via Boada, 1959

(Eocene – Spain and Italy); *Eopaguropsis* van Bakel, Fraaije, Jagt & Artal, 2008 (late Oxfordian – Germany); *Paguristes* Dana, 1851 (?late Santonian-middle Campanian – Antarctic; Campanian, Maastrichtian – United States; Maastrichtian – The Netherlands; Paleocene – United States; Lutetian and Priabonian – Italy; Miocene – United States); *Petrochirus* Stimpson, 1859 (Late Cretaceous – United States; Lutetian and Priabonian – Italy; Oligocene – W India; Miocene – Panama, N America, and N Africa; Pliocene – N America) (updated after Glaessner, 1969).

Genus *Striadiogenes* nov.

Diagnosis: shield longer than broad; postantennal projections poorly developed; anterior region narrow and slightly raised centrally; subelliptic raised and calcified central part of shield marked by transverse and oblique striae medially and proximally, and divided by a short medial gastric groove proximally; proximal and medial sections of central part of shield flat, distal part inclined backwards marked by irregular roughness and divided by a thin medial ridge; pointed rostrum weakly developed; anterior margin weakly concave; anterolateral regions strongly raised and marked by a weak roughness mixed with small pits; posterolateral and posterior regions flat and well-marked by grooves; cervical groove and *linea transversalis* present and subparallel; ocular peduncles slightly longer than half length of shield; chelipeds equal and strong; chelipeds with chela longer than broad; fingers moderately curved ventromesially; merus and carpus of cheliped with corrugated striae partially superimposed and arranged vertically on outer face; palm of cheliped with small and flat tubercles on outer face; ambulatory legs strong and flat with corrugated dorsal and ventral margins; dactyli of ambulatory legs broadly curved, approximately as long as propodi; P4 semichelate; P4-P5 considerably smaller than P2-P3.

Fig. 2 – *Striadiogenes frigerioi* n. gen., n. sp., reconstruction of cephalic shield / ricostruzione dello scudo cefalico.

Etymology: combination of Latin, *stria, -ae* (stria), referred to the ornamentation with transverse striae of subelliptic raised and calcified central part of the shield and the generic name *Diogenes* Dana, 1852, denoting an early member of Diogenidae Ortmann, 1892.

Type species: *Striadiogenes frigerioi* n. gen., n. sp.

Description: as for the type species.

Striadiogenes frigerioi n. gen., n. sp.
Figs. 2-8

Diagnosis: as for the genus.

Etymology: the trivial name alludes to I. Frigerio who donated the studied specimen.

Holotype: MSNM i27213 (part and counter-part).

Type locality: Hadjula (Lebanon).

Geological age: Late Cretaceous (Cenomanian).

Material and measurements: one complete and articulated specimen in dorsal view.

MSNM i27213 – Supposed length of carapace: 18
Width of carapace: 8
Length of shield: 9
Width of shield: 7
Length of ocular peduncles: 5
Length of chela of left and right cheliped: 13
Length of palm of left and right chela: 10
Width of palm of left and right chela: 6
Length of merus of right P2: 14
Length of carpus of right P2: 6
Length of dactylus P3: 15
Length of abdomen: 13
Width of abdomen: 10
Antennular and antennal peduncles not preserved.

Description. Shield longer than broad; postantennal projections poorly developed; anterior region narrow and slightly raised centrally; subelliptic raised and calcified central part of shield marked by transverse and oblique striae medially and proximally, and divided by a short medial gastric groove proximally; proximal and medial sections of central part of shield flat, distal part inclined backwards marked by irregular roughness and divided by a thin medial ridge; pointed rostrum weakly developed; anterior margin weakly concave with ocular incisions weakly developed; anterolateral regions strongly raised and marked by a weak roughness mixed with small pits; posterolateral and posterior regions flat well marked by grooves; cervical groove and *linea transversalis* present and subparallel; posterior carapace with central calcified gastric tract preserved.

Ocular peduncles slightly longer than half length of shield; distal parts of left and right antennal flagellae preserved (visible by ultraviolet light).

Chelipeds equal and strong; subrectangular and elongate merus; subtriangular and short carpus; palm longer than broad with subtriangular fixed finger broad at base with rounded distal extremity; thin movable finger about as long as mesial margin

of palm; corrugated dorsal margin of left chela; merus and carpus of chelipeds with corrugated striae partially superimposed and arranged vertically; palm of chelipeds weakly tuberculate dorso-ventrally and with scale-like ornamentation centrally.

Left and right ambulatory legs equal, exceeding chelipeds by approximately 0.25 length of dactylus; corrugated dorsal and ventral margins; merus and carpus of P2-P3 with corrugated striae partially superimposed and arranged vertically; dactyli broadly curved approximately as long as propodi, and terminating in sharp corneous claws; proximal part of dactyli with one marked ridge extended medially; numerous small pits not aligned dorsally and distributed along all length of dactyli.

Fig. 3 – *Striadiogenes frigerioi* n. gen.; n. sp., reconstruction / ricostruzione.

Left and right P4-P5 visible by ultraviolet light; P4-P5 with merus, carpus, propodus, and dactylus thin and smooth; right P4 semichelate; P5 probably achelate; P4-P5 considerably smaller than P2-P3.

U-shaped uncalcified abdomen longer than broad with margins preserved as imprint (visible under ultraviolet light); abdomen curved on right side and shorter than carapace; calcified intestine tract preserved centrally extending for entire length of abdomen; telson and uropods poorly preserved.

Discussion. As reported by many authors, the systematics of Recent Paguroidea uses essentially morphological dorsal and ventral characters of the body to distinguish genera and species of each family. Since the studied specimen does not preserve ventral characters useful for its identification, only some dorsal diagnostic characters, such as the ornamentation of gastric region, the chelae of chelipeds, the ornamentation of chelipeds and ambulatory legs can be used for its taxonomic ascription.

As reported by McLaughlin (2003) the superfamily Paguroidea includes at present the following extant families, Coenobitidae Dana, 1851; Pylochelidae Bate, 1888; Diogenidae Ortmann, 1892; Lithodidae Samouelle, 1819; Pylojacquesidae McLaughlin & Lemaitre, 2001; Paguridae Latreille, 1802; and Parapaguridae Smith, 1882.

Comparing the general morphology of the carapace and chelipeds with the diagnostic characters of these families (McLaughlin & Lemaitre, 2001; Poore, 2004) the studied specimen is assigned to the Diogenidae.

Diogenidae is represented in the fossil record from the Cretaceous by two genera, *Paguristes* Dana, 1851, and *Annuntidiogenes* Fraaije, van Bakel, Jagt & Artal, 2008. The comparison between *Striadiogenes frigerioi* n, gen, n. sp. and the fossil representatives ascribed to *Paguristes* from United States, Antarctica, and Europe is difficult because the last named genus is represented by only isolated and fragmentary chelae. The ornamentation with strong tubercles aligned in parallel ridges on the palm in *P. whitteni* and in *P. ouachitensis*, the ornamentation with finely granulated ridges on the palm in *P. florae*, the ornamentation with densely and uniformly spaced nodes on the palm in *P. santamartaensis*, and the ornamentation with tubercles interspersed with very small granules in random pattern on the palm in *P. tuberculatus* exclude the new genus from *Paguristes* because it has a weakly tuberculate dorso-ventral surface of the palm with a scale-like ornamentation centrally.

Annuntidiogenes, represented by three species (two from the late Albian of Spain and one from the Maastrichtian of The Netherlands) has an ovate cephalic shield divided into distinct regions, ornamented with scabrous, irregular pits, with an elongate anterior-gastric groove, and with the propodus of the chela covered with short transverse striae. *Annuntidiogenes sunuciorum* is the only Late Cretaceous species of the genus, preserved as one single incomplete carapace *in situ*. *Striadiogenes* n. gen. differs from this hermit crab from The Netherlands in having a subelliptic raised and calcified central part of shield marked by transverse and oblique striae, divided by a short medial gastric groove proximally, flat proximal and medial sections of the central part, distal section inclined backwards marked by irregular roughness and divided by a thin medial ridge.

Finally, among the Recent genera of Diogenidae, some genera, such as *Clibanarius* Dana, 1852, *Cancellus* H. Milne Edwards, 1836, and *Paguristes* Dana, 1851, show some morphological characters similar to those observed in the studied specimen, like the small, short rostrum and the equal chelipeds.
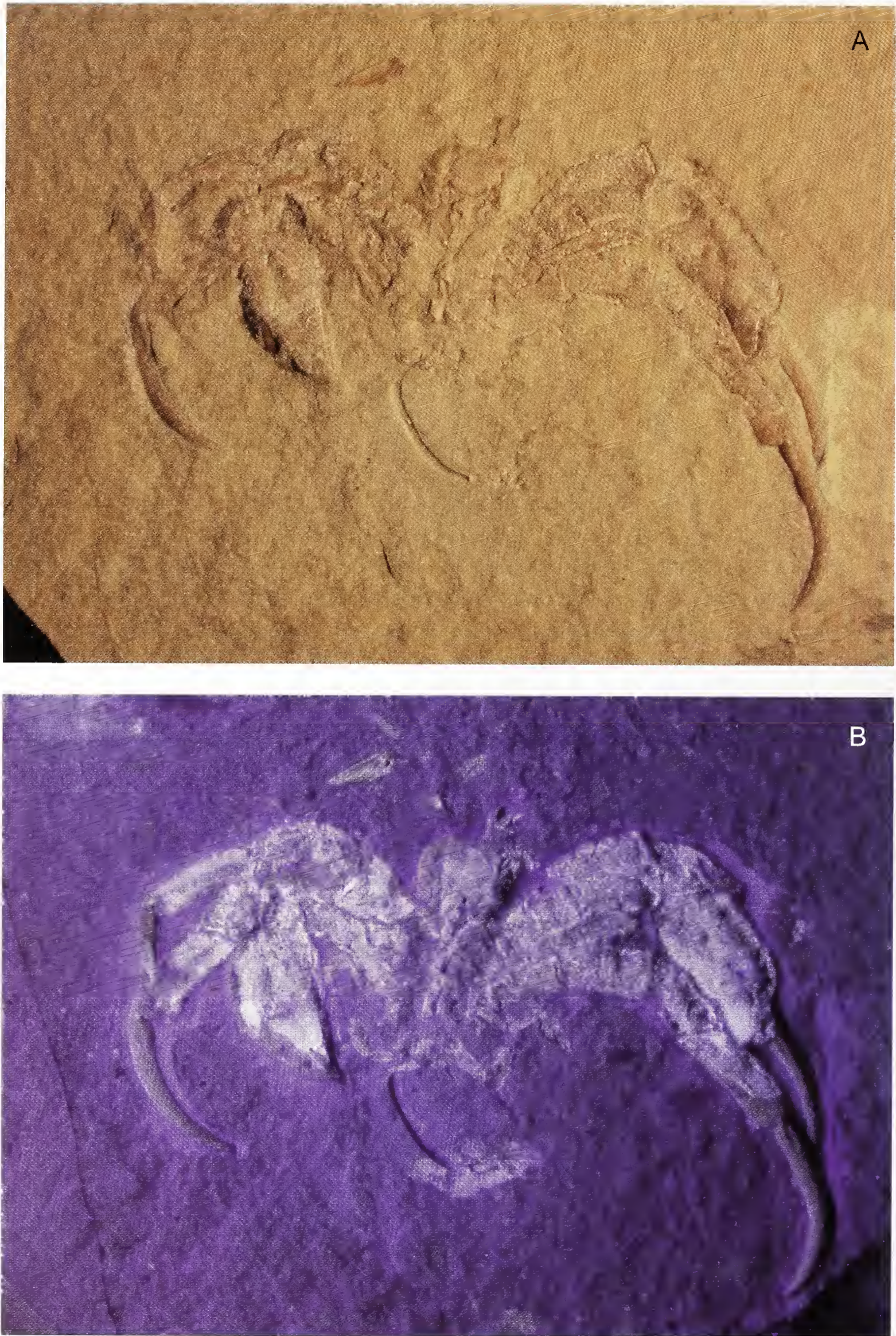
Fig. 4 – *Striadiogenes frigerioi* n. gen., n. sp., holotype / olotipo, MSNM i27213 (natural size / misura al naturale). A) specimen in natural light / esemplare a luce naturale. B) specimen in ultraviolet light / esemplare a luce ultravioletta.

Fig. 5 – *Striadiogenes frigerioi* n. gen., n. sp., detail of cephalic shield / dettaglio dello scudo cefalico (x 8.3).

Fig. 6 – *Striadiogenes frigerioi* n. gen., n. sp., detail of ornamentation of merus of P2 / dettaglio dell'ornamentazione del merus di P2 (x 9).

Fig. 7 – *Striadiogenes frigerioi* n. gen., n. sp., right chela of cheliped / chela destra del chelipede (x 8.3).

Fig. 8 – *Striadiogenes frigerioi* n. gen., n. sp., dactylus of P3 / dactylus di P3 (x 7.5).

Geological and palaeoecological notes

The representatives of the Recent Diogenidae inhabit various natural refuges, commonly gastropod shells, to protect the soft body (Walker, 1992).

The reports of hermit crabs *in situ* are rare in the fossil record, limited to a few incomplete specimens preserved in ammonite body chambers or in gastropod shells (Mertin, 1941; Hyden & Forest, 1980; Feldmann & Keyes, 1992; Fraaije, 2003; Jagt *et al.*, 2006; Fraaije *et al.*, 2008; van Bakel *et al.*, 2008; Garassino *et al.*, 2009).

Striadiogenes frigerioi n. gen., n. sp. is the first hermit crab with complete preservation, showing the uncalcified U-shaped abdomen and very reduced P4 and P5, both indicative characters of adaptation occupying solid protective structures.

Any track or remain of possible refuge is not present on the slab preserving the studied specimen.

The sublithographic limestones of Hadjula contain only sparce remains of shelled cephalopods, usually small sized, like some planispiral specimens belonging to the Achanthoceratidae de Grossouvre, 1894, one heteromorphic specimen belonging to the Anisoceratidae Hyatt, 1900, with *Allocrioceras* cfr. *annulatum* (Shumard, 1860) (Wippich & Lehmann, 2004), and one nautiloid, *Nautilus* sp. The gastropods are almost absent (Garassino, pers. comm., 2008). Because of the paucity and usually small size of shelled cephalopods and gastropods we infer that *Striadiogenes frigerioi* n. gen., n. sp. lived in a different environment inside the basin.

Roger (1946) interpreted the depositional environment to be a deep trough between rudist patch-reefs. Later Hückel (1970) proposed a more complex model in which the shelf was collapsed locally forming a series of "pools" where mudstones were deposited under low energy and anoxic conditions.

If these reconstructions are correct, we can suppose that the life environment of *Striadiogenes* was into the crevices within the walls of the shelf or in crevices in the rudist-reef. Moreover the elongate valves of the rudists could also be a possible valid refuge.

Surely, the life environment of *Striadiogenes* was different from the depositional environment and its fossilization occurred only after its vertical fall into the bottom of the depositional pool of the basin.

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In situ hermit crab (Crustacea, Anomura, Paguroidea) from the Early Eocene (Ypresian) of NE Italy

Abstract - Hermit crabs from the Eocene of Italy have been reported by several authors who described only fragmentary and complete chelae of chelipeds. The studied specimen from the Early Eocene (Ypresian) of Monte Baldo (Verona, NE Italy) has been ascribed to *Paguristes* Dana, 1851, with *P. baldoensis* n. sp. (Diogenidae Ortmann, 1892). It represents the first report of hermit crab *in situ* from Italy.

Key words: Crustacea, Anomura, Paguroidea, Early Eocene, Italy.

Riassunto - Paguro *in situ* (Anomura, Paguroidea) dell'Eocene inferiore (Ypresiano) dell'Italia nordorientale.

Paguridi dell'Eocene d'Italia sono stati segnalati da alcuni autori che hanno descritto solo chele complete o incomplete dei chelipedi. L'esemplare studiato dell'Eocene inferiore (Ypresiano) del Monte Baldo (Verona, NE Italia) è stato ascritto a *Paguristes* Dana, 1851, con *P. baldoensis* n. sp. (Diogenidae Ortmann, 1892). Si tratta della prima segnalazione di un paguride *in situ* per l'Italia.

Parole chiave: Crustacea, Anomura, Paguroidea, Eocene inferiore, Italia.

Introduction

As reported by Glaessner (1969), fossil hermit crabs are usually known only for the strongly calcified parts, like chelipeds and ambulatory legs, while the shield is rarely preserved. Shäfer (1972) and later Walker (1992) pointed out that "as a rule, hermit crabs are not preserved within the gastropod shell". In fact, the fossil record of hermit crabs preserved *in situ* is exceptionally rare, limited to date to about ten specimens formerly recognized, that ranges from the Early Jurassic to the Pliocene, presumably due to a previous selective sampling in field prospections or, according to van Bakel *et al.* (2008), for merely inattention rather than of really paucity.

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Jagt *et al.* (2006) reported the earliest hermit crab *in situ* referred to *Palaeopagurus* Van Straelen, 1925, including a probable new species, from the upper Pliensbachian (Early Jurassic) of southern Germany, preserved in a fragmentary body chamber of the amaltheid ammonite *Pleuroceras solare*.

van Bakel *et al.* (2008) reported *Ammopylocheles mclaughlinae* van Bakel, Fraaije, Jagt & Artal, 2008, preserved within the body chamber of an empty perisphinctid ammonite shell from the Kimmeridgian (Early Jurassic) of southern Germany.

Fraaije (2003) reported *Palaeopagurus vandenengeli* Fraaije, 2003, preserved within the shell of the ammonite *Simbirskites gottschei* from the middle Hauterivian (Lower Cretaceous) of United Kingdom.

Breton & Collins (2007) reported a single specimen with chelipeds and ambulatory legs, poorly preserved and very compressed, of an indeterminate ?*Pagurus* sp. within a ?natacid gastropod from the Cenomanian (Late Cretaceous) of Le Mans (France).

Feldmann *et al.* (1993), described *Paguristes santamartaensis* Feldmann, Tshudy & Thomson, 1993, by two chelipeds associated with an external mould of the gastropod *Taioma* from the ?late Santonian- middle Campanian (Late Cretaceous) of Antarctica.

Fraaije *et al.* (2008) reported *Annuntidiogenes sunuciorum* Fraaije, van Bakel, Jagt & Artal, 2008, preserved within a volutoid gastropod from the Maastrichtian (Late Cretaceous) of The Netherlands.

Collins & Jakobsen (2003) described *Pagurus*? *langei* Collins & Jakobsen, 2003, within the body chamber of *Volutocorbis* sp. from the Eocene (Ypresian/ Lutetian) of Lillebaelt Clay Formation of Jutland (Denmark).

Jagt *et al.* (2006) reported chelipeds and ambulatory legs of an indeterminate paguroid ("*Pagurus damesii*" Noetling, 1885, *nomen dubium*) within a internal mould of a ?volutid gastropod from the Middle Eocene of eastern Prussia (Russia).

Karasawa (2002) reported remains of pereiopods 1-3 of *Pagurus* (s.l.) sp. preserved within *Turritella infralirata* from the Early Late Oligocene of Japan.

Hyden & Forest (1980) reported *Pagurus clifdenensis* Hyden & Forest, 1980, within a damaged shell of the gastropod *Struthiolaria subspinosa* from the Early Miocene of New Zeland.

Finally, Dunbar & Nyborg (2003) reported the discovery of three specimens of hermit crabs, ascribed to *Isocheles* sp., associated with their host gastropod shell from the Pliocene of the San Diego Formation of California (United States).

Geological setting

The mountain chain of Monte Baldo, between Verona and Trento provinces (NE Italy), expands from N to S. It is included between the eastern bank of Garda Lake and the right orographic bank of Adige River. The geological section of the eastern side of the mountain chain includes some sedimentary series from the Late Jurassic to the Late Eocene (Fabiani, 1915; Luciani, 1987, 1989). A continuous series of marly limestones and Eocene marls of marine origin crops out close to the village of Ferrara del Baldo (Verona) (Fig. 1). The bottom of the series has been referred to the Early Eocene, including different invertebrates, such as brachyurans belonging to *Harpactocarcinus* and echinoderms belonging to *Pentacrinus* (Fabiani, 1915).
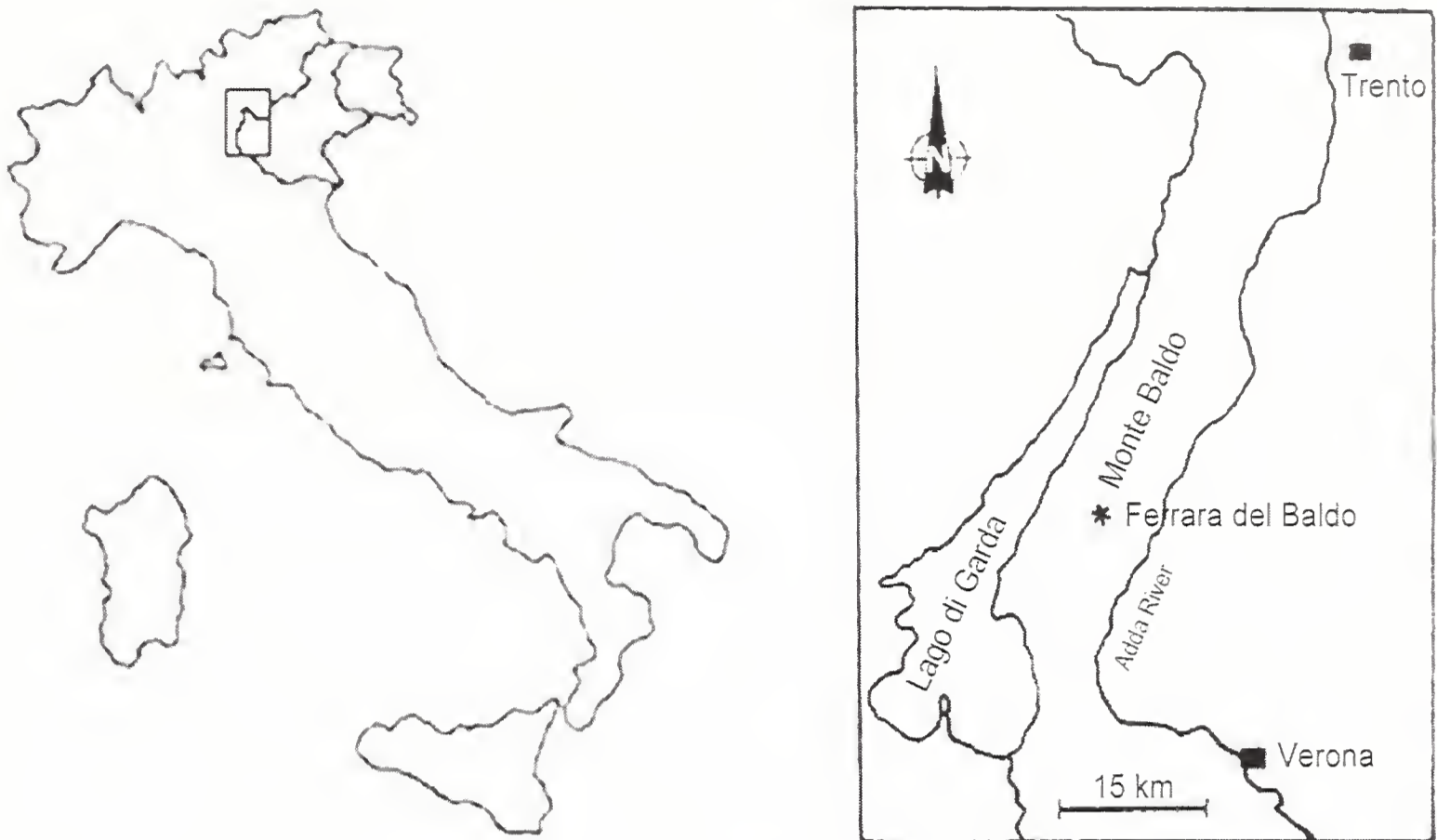
Fig. 1 – Geographical map with fossiliferous locality (*) / mappa geografica con ubicazione della località fossilifera (*).

The studied specimen was discovered in this level and therefore ascribed to the Early Eocene (Ypresian), also for the presence of one fragmentary specimen of *Pentacrinus* cfr. *P. diaboli*, typical of the Early Eocene (Fabiani, 1915; Siliotti, 1971), associated with the studied specimen within the body chamber of the coeval cerithid *Pseudovertagus*.

Previous reports of hermit crabs from the Eocene of Italy

As reported by De Angeli & Garassino (2006) and Beschin *et al.* (2007), the fossil record of Paguroidea from the Eocene of Italy includes only Diogenidae Ortmann, 1892.

Diogenidae includes *Calcinus* Dana, 1851, *Ciliopagurus* Forest, 1995, *Dardanus* Paulson, 1875, *Diogenes* Dana, 1851, *Eocalcinus* Via Boada, 1959, *Paguristes* Dana, 1851, and *Petrochirus* Stimpson, 1859. Only fragmentary and complete chelae of chelipeds are known from the Eocene of Italy to date for this family, as reported by Beschin *et al.* (1994, 2002, 2005, 2006, 2007), De Angeli (1995), and Vicariotto (1997). So the studied specimen represents the first report of hermit crab *in situ* from Italy, enlarging also the very poor knowledge about the life-style ways among the fossil paguroids.

Material

The studied specimen is preserved *in situ* in an inner mould of gastropod, probably belonging to *Pseudovertagus* (*Striovertagus*) *striatus* (Bruguiere, 1792), a cerithid usually common from the late Ypresian to middle Lutetian of Veneto (Quagiotto, pers. comm., 2008). Even though we suppose that the complete shield is

preserved within the body chamber of the second turn of the shell, only the chelae and the right carpus of chelipeds were cleaned after the preparation by air gravers due to the hard nature of the carbonatic mould of the gastropod shell. The studied specimen has been ascribed to the infraorder Anomura MacLeay, 1838, including *Paguristes baldoensis* n. sp. (Diogenidae Ortmann, 1892).

The specimen is housed in the Palaeontological Collections of the Museo di Storia Naturale, Milano (MSNM). Measurements are given in millimetres (mm).

Systematic Palaeontology

Order Decapoda Latreille, 1802
Infraorder Anomura MacLeay, 1838
Superfamily Paguroidea Latreille, 1802
Family Diogenidae Ortmann, 1892

Included fossil genera: *Annuntidiogenes* Fraaije, van Bakel, Jagt & Artal, 2008 (late Albian – Spain; Maastrichtian – The Netherlands); *Calcinus* Dana, 1851 (Lutetian – Italy; Pliocene – Italy); *Ciliopagurus* Forest, 1995 (Oligocene – Belgium; Badenian – Hungary); ?*Clibanarius* Dana, 1852 (?Late Eocene – Egypt); *Dardanus* Paulson, 1875 (Eocene – United States and Egypt; Oligocene – Asia; Lutetian – Italy; Miocene – Europe; Pliocene – Italy and Fiji; Pleistocene – United States); *Diogenes* Dana, 1851 (Ypresian – Italy); *Eocalcinus* Via Boada, 1959 (Eocene – Spain and Italy); *Eopaguropsis* van Bakel, Fraaije, Jagt & Artal, 2008 (late Oxfordian – Germany); *Paguristes* Dana, 1851 (?late Santonian-middle Campanian – Antarctic; Campanian, Maastrichtian – United States; Maastrichtian – The Netherlands; Paleocene – United States; Lutetian and Priabonian – Italy; Miocene – United States); *Petrochirus* Stimpson, 1859 (Late Cretaceous – United States; Lutetian and Priabonian – Italy; Oligocene – W India; Miocene – Panama, N America, and N Africa; Pliocene – N America); *Striadiogenes* Garassino, De Angeli & Pasini, 2009 (Cenomanian – Lebanon) (updated after Glaessner, 1969).

Genus *Paguristes* Dana, 1851

Type species: *Paguristes hirtus* Stimpson, 1858.

Included Italian fossil species: *P. extentus* Beschin, Busulini, De Angeli & Tessier, 2007 (Early Eocene – Ypresian); *P. prealpinus* Beschin, De Angeli, Checchi & Zarantonello, 2005 (Middle Eocene – Lutetian); *P. lineatuberculatus* Beschin, De Angeli, Checchi & Mietto, 2006 (Late Eocene – Priabonian).

Paguristes baldoensis n. sp.
Figs. 2-4

Diagnosis: chelae subequal, subrectangular in outline; left chela slightly longer and larger than right chela; right chela elongate with upper and lower margins almost rectilinear; corrugated upper margin of palm; lower margin of palm straight and smooth; movable and fixed fingers elongate and strong; corrugated upper margin of

movable finger; interdigital margin strongly inclined; articulation carpo-propoidale straight; ornamentation of chela with strong tubercles not aligned.

Etymology: the trivial name alludes to Monte Baldo where the studied specimen was discovered.

Holotype: MSNM i27220.

Geological age: Early Eocene (Ypresian).

Type locality: Ferrara di Monte Baldo (Verona).

Fig. 2 – *Paguristes baldoensis* n. sp., MSNM i27220, holotype / olotipo (x 2).

Occurrence: one specimen *in situ* that preserves only the chelipeds.
Length of carpus of right chela: 4
Length of right chela: 8
Length of palm of right chela: 5
Width of palm of right chela: 4
Length of left chela: 10
Length of palm of left chela: 5
Width of palm of left chela: 5
Length of fixed finger of right chela: 4
Length of movable finger of right chela: 6
Maximum length of shell: 60
Maximum width of shell: 20

Description. Left and right chelae subequal in size, subrectangular in outline, strongly broader proximally; left chela slightly longer and larger than right chela; the upper margin is slightly curved and corrugated; the lower margin is straight and smooth, continuous with the stout fixed finger and smooth from the tip of the fixed finger to the carpal margin; the palm is subquadrate in outline; the interdigital margin is strongly inclined, smooth, with two slight depressions divided by a medial slight bulge; the fixed finger is almost as long as the palm with the tip shallowly spooned; the movable finger is stout, elongate, with corrugated upper margin and lateral pits; the outer surface of the left and right chelae is gently convex with strong tubercles not aligned and uniformly distributed; the articulation carpo-propoidale is straight; the carpus is subquadrate in outline with the carpus-merus articulation less wide than the carpo-propodiale articulation; upper margin of carpus smooth and gently inflated laterally.

Discussion. As reported by many authors, the systematics of Recent Paguroidea uses essentially morphological dorsal and ventral characters of the body to distinguish genera and species of each family. Since, the studied specimen does not preserve dorsal or ventral characters useful for its identification, only the shape of the chelae of chelipeds and the ornamentation of chelipeds can be used for its taxonomic ascription.

As reported by McLaughlin (2003) the superfamily Paguroidea includes at present the following Recent families, Coenobitidae Dana, 1851, Pylochelidae Bate, 1888, Diogenidae Ortmann, 1892, Lithodidae Samouelle, 1819, Pylojacquesidae McLaughlin & Lemaitre, 2001, Paguridae Latreille, 1802, and Parapaguridae Smith, 1882.

Comparing the general morphology of the chelipeds of the studied specimen with the diagnostic characters of these families (McLaughlin & Lemaitre, 2001; Poore, 2004), it is assigned to the Diogenidae and to *Paguristes* Dana, 1851, for the chelae subequal, the palm subquadrate having a corrugated upper margin, and the interdigital margin strongly inclined.

In the fossil record from the Eocene of Veneto, *Paguristes* is represented with three species, *P. prealpinus* Beschin, De Angeli, Checchi & Zarantonello, 2005, *P. lineatuberculatus* Beschin, De Angeli, Checchi & Mietto, 2006, and *P. extentus* Beschin, Busulini, De Angeli & Tessier, 2007. A morphological resemblance exists between the studied specimen and *P. extentus* for the elongate outline of the chela and the interdigital margin strongly inclined and smooth. However, two characters distinguish the new species from *P. extentus*, the stout fixed finger almost as long as the palm with the tip shallowly spooned and the corrugated upper margin of

the palm. The elongate chelae subequal with corrugated upper margin, the elongate movable finger with corrugated upper margin, the interdigital margin strongly inclined, smooth, with two slight depressions divided by a medial slight bulge, and the ornamentation of palm with strong tubercles not aligned distinguish *P. baldoensis* n. sp. from *P. prealpinus* and *P. lineatuberculatus*, both having a fixed finger with distal tip directed downwards, interdigital margin slightly inclined and straight, and ornamentation of palm with small tubercles.
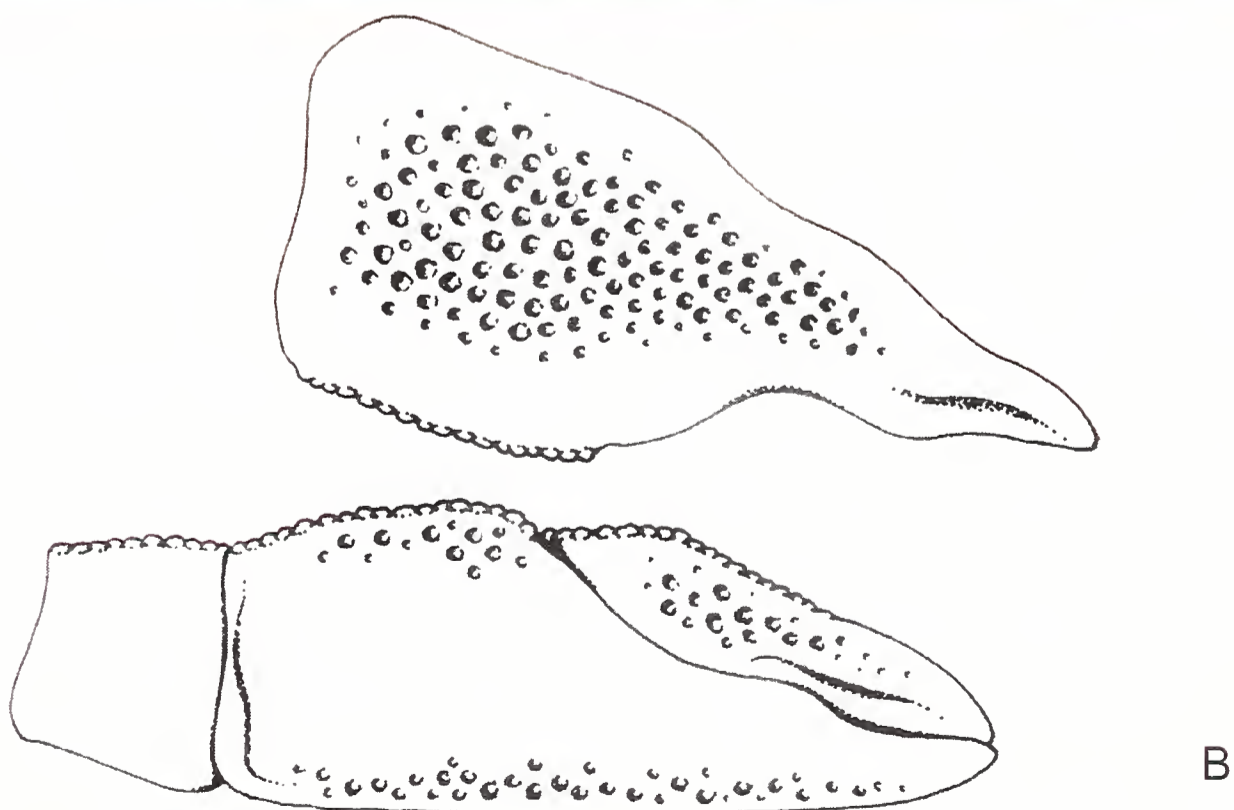
Fig. 3 – *Paguristes baldoensis* n. sp., MSNM i27220. A) detail of the chelae / dettaglio delle chele. B) reconstruction of the chelae / ricostruzione delle chele. (x 6).

Taphonomic and palaeoecological notes

The studied specimen shows both chelipeds exposed, ranged subparallel in lateral view and in life position. The original shell, probably belonging to *Pseudovertagus* (*Striovertagus*) *striatus*, was dissolved during the diagenesis process and only the general form of the helicoidal spire, laterally compressed, and the outline development are visible, as internal mould. This kind of preservation allows to recognize the presence of the chelae into the shell.

Recent species of *Pseudovergatus* live on sandy bottoms and soft sediments in subtropical intertidal-sublitoral and brackish waters near the costal line. A similar environment is supposed for the Eocene in Veneto area, intercalated with local important volcanic events.

Moreover, some Recent small sized hermit crabs living in the Mediterranean Sea, such as *Clibanarius erytropus*, have a preference to inhabit the empty shells of several Cerithiidae in addition to a few other gastropods (Grecchi & Balestrazzi, 2002).

Other extra-Mediterranean examples are the "hermitted" shells (*sensu* Walker, 1992) of Recent *Cerithium stercusmuscarum* from the Cortez Sea (Mexico) (Walker, 1992). As reported by Tunberg *et al.* (1994), also the small shells of *Cerithium muscarum*, in the estuarine subtropical environment of the Indiana River Lagoon on the Atlantic coast of Florida (United States) are observed as an important habitat resource for *Pagurus maclaughinae*. Another example is *Diogenes pugilator* Roux, 1828, inhabiting the shells of *Ceritium vulgatum* along the coastal environment of the Crimea Peninsula in the Black Sea.

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A new theropod dinosaur, represented by a single unusual caudal vertebra, from the Kem Kem Beds (Cretaceous) of Morocco

Abstract - We describe a near-complete distal caudal vertebra from an Upper Cretaceous theropod, discovered in the Kem Kem Beds (Cenomanian) of Tafilalt, Morocco. The specimen exhibits an extremely unusual combination of features , and we herein erect a new species, *Kemkemia auditorei* gen. et sp. nov. The specimen differs from other theropod distal caudal vertebrae in the presence of a relatively inflated neural canal, strongly reduced zygapophyses, a low but very robust neural spine bearing shallow lateral fossae, a mediolaterally concave dorsal surface of the neural spine, and coalescence of the postzygapophyses in a position more proximal than the region where neural spines are absent. Although *Kemkemia* shares some derived features with neoceratosaurs, we provisionally refer it to Neotheropoda *incertae sedis*, pending the discovery of more complete material. Several distal caudal vertebrae from the Maastricthian of India are similar to *Kemkemia*, and may belong to a closely related taxon.

Key words: *Kemkemia auditorei* gen. et sp. nov., Theropoda, caudal vertebra, Morocco, Cenomanian.

Riassunto - Un nuovo dinosauro teropode, rappresentato da un'inusuale vertebra caudale, proveniente dai Letti del Kem Kem (Cretacico) del Marocco.

In questo studio descriviamo una vertebra caudale quasi completa del Cretacico superiore (Cenomaniano) di Tafilalt, Marocco. Sulla base dell'inusuale combinazione di caratteristiche presenti in questo esemplare, abbiamo eretto una nuova specie di teropode, *Kemkemia auditorei* gen. et sp. nov. Essa si distingue dalle caudali distali dei teropodi noti per: presenza di un canale neurale relativamente espanso, zigapofisi estremamente ridotte, presenza di una spina neurale bassa ma robusta avente deboli fosse laterali, superficie dorsale della spina concava mediolateralmente, fusione delle postzigapofisi che avviene lungo le caudali prossimalmente alla perdita della spina neurale. Sebbene *Kemkemia* condivida alcuni caratteri derivati con i neoceratosauri, attribuiamo provvisoriamente questo taxon a Neotheropoda *incertae sedis*. Numerose caudali distali di teropode del Maastrichtiano dell'India mostrano una morfologia simile a *Kemkemia* e potrebbero dunque appartenere ad un taxon imparentato con il nuovo teropode marocchino.

Parole chiave: *Kemkemia auditorei* gen. et sp. nov., Theropoda, vertebra caudale, Marocco, Cenomaniano.

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Introduction

In recent decades, several theropod dinosaurs have been reported from the mid Cretaceous (Aptian-Turonian) of North Africa (Sereno *et al.*, 1994; Russell, 1996; Sereno *et al.*, 1996; Sereno *et al.*, 1998; Riff *et al.*, 2004; Sereno *et al.*, 2004; Mahler, 2005; Novas *et al.*, 2005a; Brusatte & Sereno, 2007; Sereno & Brusatte, 2008). Most have been referred to abelisauroid and basal (non-coelurosaurian) tetanuran clades of middle to large body size. In May 1999, the Palaeontological Section of the Museo di Storia Naturale di Milano, in collaboration with the Geological Service of Morocco and with the logistical support of F. Escuillié (Eldonia, France) and G. Pasini (Fossilia snc., Italy), carried out a palaeontological expedition in the southern part of the Errachidia Province, Morocco, focussing on invertebrate fauna (Alessandrello & Bracchi, 2003). Prospecting was also carried out in the Tafilalt, near Erfoud. The most interesting find from the region was an almost complete caudal vertebra, collected as a surface find south of Erfoud, a few kilometers to the east of the small village of Taouz and toward the direction of Hamada du Guir (Pasini, pers. comm., 2008; Fig. 1). On the basis of an unusual combination of features present in this vertebra, we formally erect a new species of theropod dinosaur.
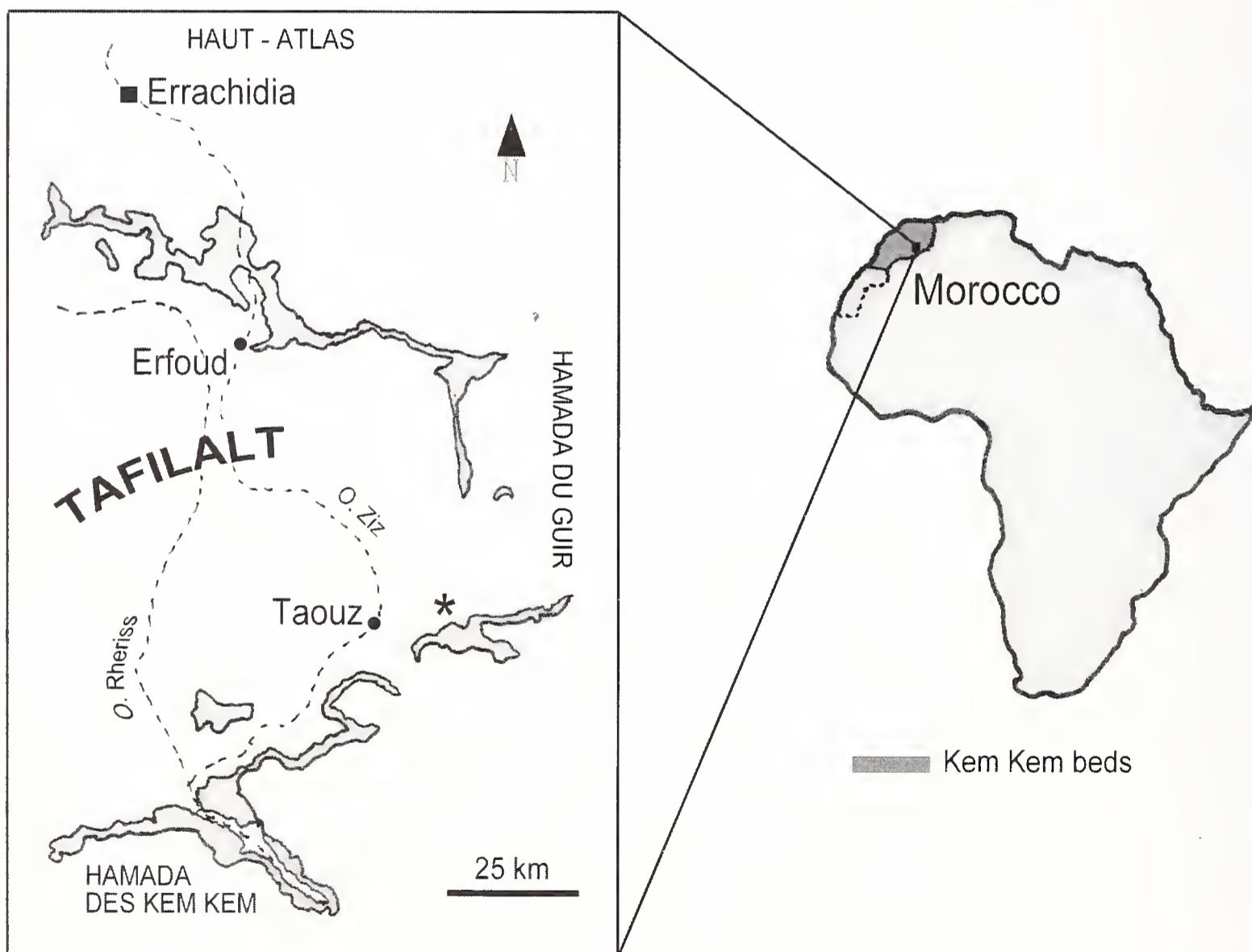
Fig. 1 - Geographic map of the fossil location south of Erfoud, east of the village of Taouz, toward the Hamada du Guir, Errachidia Province, Morocco; the main localities and landscape elements cited in the text are shown in the map. The asterisk marks the site from where the specimen MSNM V6408 was collected (drawing by SM and G. Pasini; based on the original drawing by Garassino *et al.*, 2006).
Fig. 1 - Cartina geografica indicante il punto di rinvenimento dell'esemplare, a S di Erfoud e ad E del villaggio di Taouz, in direzione di Hamada du Guir (provincia di Errachidia, Marocco), in cui sono evidenziati le principali località e i toponimi citati nel testo. L'asterisco indica la località da cui proviene l'esemplare MSNM V6408 (disegno di SM e G. Pasini, basato sul disegno originale di Garassino *et al.*, 2006).

Istitutional abbreviations: **GSI**: Geological Survey of India, Kolkata, India; **IGM**: Mongolian Institute of Geology, Mongolian Academy of Science, Ulan Bator, Mongolia; **MSNM**: Museo di Storia Naturale di Milano, Italy; **NMC**: Canadian Museum of Nature, Ottawa, Ontario, Canada; **UCPC**: University of Chicago, Paleontological Collection, Chicago, USA.

Materials and methods

The specimen is catalogued in the Vertebrate Palaeontological Collection of the Museo di Storia Naturale di Milano (MSNM V) as MSNM V6408.

Following Weishampel *et al.* (2004), we adopt the following anatomical terms of the *Nomina Anatomica Veterinaria* (NAV 1994) and the *Nomina Anatomica Avium* (NAA 1993): ventral (toward the belly), dorsal (toward the back), proximal (toward the mass of the body), and distal (away from the mass of the body). For saurischian and ceratosaurian systematic terminologies we follow Padian *et al.*, (1999) and Wilson *et al.* (2003), respectively. Accordingly, we consider Neotheropoda the least inclusive clade containing *Coelophysis bauri* and extant birds; Ceratosauria the most inclusive clade containing *Ceratosaurus nasicornis* but not extant birds; and Tetanurae the most inclusive clade containing extant birds but not *Ceratosaurus nasicornis*.

Systematic Palaeontology

Dinosauria Owen, 1842
Saurischia Seeley, 1888
Theropoda Marsh, 1881
Neotheropoda Bakker, 1986
?Ceratosauria Marsh, 1884
Kemkemia auditorei gen. et sp. nov.

Derivatio nominis - The generic name refers to the Kem Kem Beds of Morocco, where the holotype specimen was collected. The specific name honours the Italian palaeoartist Marco Auditore, for his inexhaustible and enthusiastic support of vertebrate palaeontology.

Holotype - MSNM V6408, an almost complete distal caudal vertebra (Fig. 2) of a middle- to large-sized theropod.

Locality - Although GPS data were not recorded, the specimen comes from some kilometers south of Erfoud, east of the village of Taouz, and in the direction of the Hamada du Guir, Errachidia Province, Morocco (Fig. 1).

Horizon - Kem Kem Beds, "Infracénomanien" (Russell, 1996), Cenomanian, Upper Cretaceous (Sereno *et al.*, 1996). The Kem Kem Beds consist of channel-deposited red sandstone (Russell, 1996; Sereno *et al.*, 1996), lithologically identical to the matrix that encrusted the vertebra and filled the neural canal prior to preparation (Pasini, pers. comm., 2008). The specimen was discovered in close association with rostral teeth of the Aptian-Cenomanian elasmobranch *Onchopristis sp.* (Pasini, pers. com., 2008; Rage & Cappetta, 2002; Russell, 1996). The latter is an extremely common find in the Kem Kem Beds and is often found in association with dinosaur remains (Naish, pers. comm., 2009).

Diagnosis - Neotheropod dinosaur bearing distal caudal vertebrae with the following autapomorphies: inflated neural canal, broader than the width of the centrum at mid-length; strongly reduced finger-like prezygapophyses lacking articular facets and failing to reach the level of the articular end of the centrum; robust neural spine (in which the mediolateral width at the apex is at least 30% of the width of the cranial articular surface of the centrum); shallow fossa on the distal half of the lateral surface of the neural spine bounded distally by the postspinal lamina; mediolaterally concave dorsal surface to the neural spine.

Differential diagnosis: *Kemkemia* differs from other theropods, with the possible exception of *Ilokelesia* (Coria & Salgado, 2000) and *Ligabueino* (Bonaparte, 1996), in that the postzygapophyses coalesce at a point in the tail more proximal than the point at which loss of the neural spine occurs.

Description

The specimen MSNM V6408 (Fig. 2; Tab. 1) is a near-complete, well preserved three-dimensional caudal vertebra. The right prezygapophysis is broken at the base; the periosteum along the margins of the proximal and distal articular facets and the articular surfaces for the chevron are missing, although the outline of the chevron facets is still visible (Fig. 2D). The neural arch is completely fused to the centrum and no trace of a neurocentral suture is present. The centrum is amphicoelous, slightly more excavated proximally, and it lacks pneumatic fossae or foramina. A vascular foramen is present on the left lateral surface of the centrum (Fig. 2B). The centrum is elongate, being more than three times longer than it is tall at its proximal end. The proximal and distal articular faces are quadrangular, with a width to height ratio close to 1. The lateral surfaces are dorsoventrally concave, with the right side being slightly more concave than the left. The ventral surface is flat and very narrow, measuring (at mid-length of the centrum) no more than 45% of the ventral width of the articular facets. The neural arch is very elongate, its base occupying almost 90% of the dorsal length of the centrum. The neural canal is rounded and very large, having proximal dorsoventral and mediolateral diameters that are almost 50% the diameters of the proximal articular face of the centrum. Due to the size of the neural canal, the inflated neural arch is visible for almost its entire length when the specimen is examined in ventral view. The left prezygapophysis is an extremely reduced, finger-like process, subtriangular in dorsal view and close to the mid-line, bounding a narrow cleft housing a rounded pit. The proximal tip of the prezygapophysis does not reach the level of the proximal articular face of the centrum and lacks any distinct articular facet. A faint ridge extends from the dorsal mid-line of the prezygapophysis to the proximo-lateral base of the neural spine. This may represent a faint spinoprezygapophyseal lamina. A prominent, sharply defined prespinal lamina is present. It gradually decreases in height toward its proximal end, disappearing at the level of the distal margins of the prezygapophyseal ridges. The prespinal lamina is bounded laterally by two shallow fossae. The distal margin of the neural arch lacks postzygapophyses: it is replaced by a single, small process that does not reach as far distally as the distal end of the centrum. At its proximal end, this process unites with the postspinal lamina. This lamina is less sharp than the prespinal one, but it is

slightly taller, reaching the ventrodistal margin of the spine table. The neural spine is distally placed and short, being about 20% of the length of the neural arch. In lateral view, the spine is trapezoidal and longer than tall. The spine is broad and robust, having an apical width that is 32% the width of the cranial articular face of the centrum. The laterodistal surfaces of the spine are slightly concave. These concavities are bordered distally by the postspinal lamina. As a consequence, the proximal half of the spine is broader and more robust than the distal one, so the mid-height cross-section of the spine is tear-drop-shaped. The dorsal surface of the spine is ovate, longer than wide in dorsal view and slightly concave in both proximal and distal views. The lateral edges of the dorsal concavity are bounded by slightly developed but clearly defined margins that converge proximally.
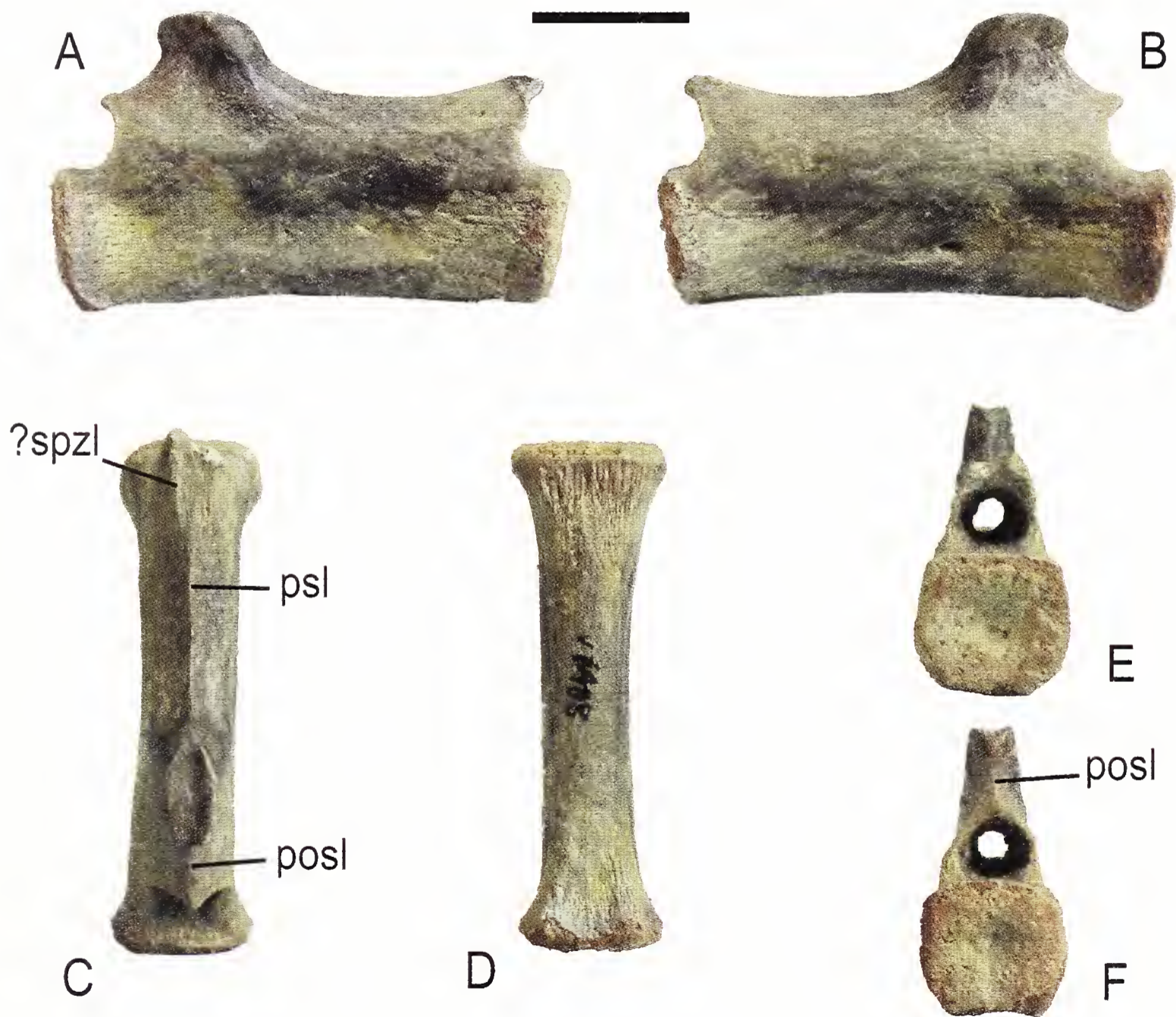
Fig. 2 - Specimen MSNM V6408 in right lateral (A), left lateral (B), dorsal (C), ventral (D), proximal (E), and distal (F) views. Abbreviations: ?spzl, ?spinoprezygapophyseal lamina; psl, prespinal lamina; posl, postspinal lamina. Scale bar equals 2 cm. (Photos by SM).

Fig. 2 - Esemplare MSNM V6408 nelle norme laterale destra (A), laterale sinistra (B), dorsale (C), ventrale (D), prossimale (E) e distale (F). Abbreviazioni: ?spzl, lamina ?spinoprezigapofiseale; psl, lamina prespinale; posl, lamina postspinale. La scala metrica equivale a 2 cm. (Foto di SM).

Tab. 1 - Basic measurements of specimen MSNM V6408.
Tab. 1 - Misure principali dell'esemplare MSNM V6408.

Selected measurements of MSNM V6408	(measurements expressed in mm)
Vertebra: maximum length	60.48
Vertebra: maximum height	33.81
Vertebra: maximum width	17.79
Centrum: maximum length	60.48
Centrum: width at mid-length	7.60
Centrum: proximal facet height	16.53
Centrum: proximal facet width	17.79
Centrum: distal facet height	15.44
Centrum: distal facet width	16.99
Neural arch: maximum height	17.33
Neural arch: length from tip of prz to tip of poz	52.21
Neural arch: width at centrum mid-length	10.91
Neural arch: top of the neural spine length	10.62
Neural arch: top of the neural spine width	5.70

Discussion

Taxonomic affinities and phylogenetic hypotheses of MSNM V6408 - On the basis of the presence of articular facets for the chevrons and the absence of transverse processes, we identify MSNM V6408 as a non-proximal caudal vertebra. The absence of transverse processes combined with the presence of a robust neural spine indicates that MSNM V6408 belongs to the transitional zone between the proximal/middle caudals (bearing both neural spines and transverse processes), and the distal-most vertebrae that lack such structures (Fig. 3). The presence of spinal laminae in caudal neural arches is a derived feature of some saurischian clades (Wilson. 1999): specifically, neosauropods and neotheropods. Accordingly, we compared the vertebra with sauropod distal caudals. MSNM V6408 shares with *Jobaria* and Neosauropoda the presence of prespinal and postspinal laminae (Wilson, 2002). MSNM V6408 shares several features with some neosauropods in which the distal caudals still bear the neural spine. In such taxa, the centrum is elongate (Wilson, 2002; Upchurch *et al.,* 2004), the articular faces are quadrangular (Osborn, 1899, Plate XXVIII; Upchurch *et al.,* 2004), and the ventral surfaces are flattened (Gomani, 1999; Salgado *et al.,* 2004). However, many features present in *Kemkemia* are unusual when compared with sauropod distal caudals: in sauropods the elongate distal caudal centra (having a length to height ratio greater than 3) are often biconvex rather than amphycoelous (Wilson *et al.,* 1999), the base of the neural arch is usually more proximodistally reduced than it is in *Kemkemia*, failing to reach the distal fifth of the centrum; the zygapophyses are more robust dorsoventrally; and the neural spine is more proximodistally elongate and projects distally

beyond the postzygapophyses (Osborn, 1899; Calvo & Salgado, 1995; Gomani, 1999; Salgado *et al.,* 2004; Harris, 2006; Sereno *et al.,* 2007). Moreover, a hypertrophied neural canal has yet to be reported in any sauropod distal caudal vertebra (Osborn, 1899: Plate XXVIII; Osborn & Mook, 1921: Plate LXXII; Gomani, 1999; Salgado *et al.,* 2004), whereas chevron facets and pre- and postspinal laminae do not persist through the distal caudal series in neosauropods (Wilson, 1999; Wilson, 2002; Kellner *et al.*, 2005). In conclusion, while some resemblances are present between MSNM V6408 and the distal caudals of some sauropods, it seems most likely that these similarities are convergent.
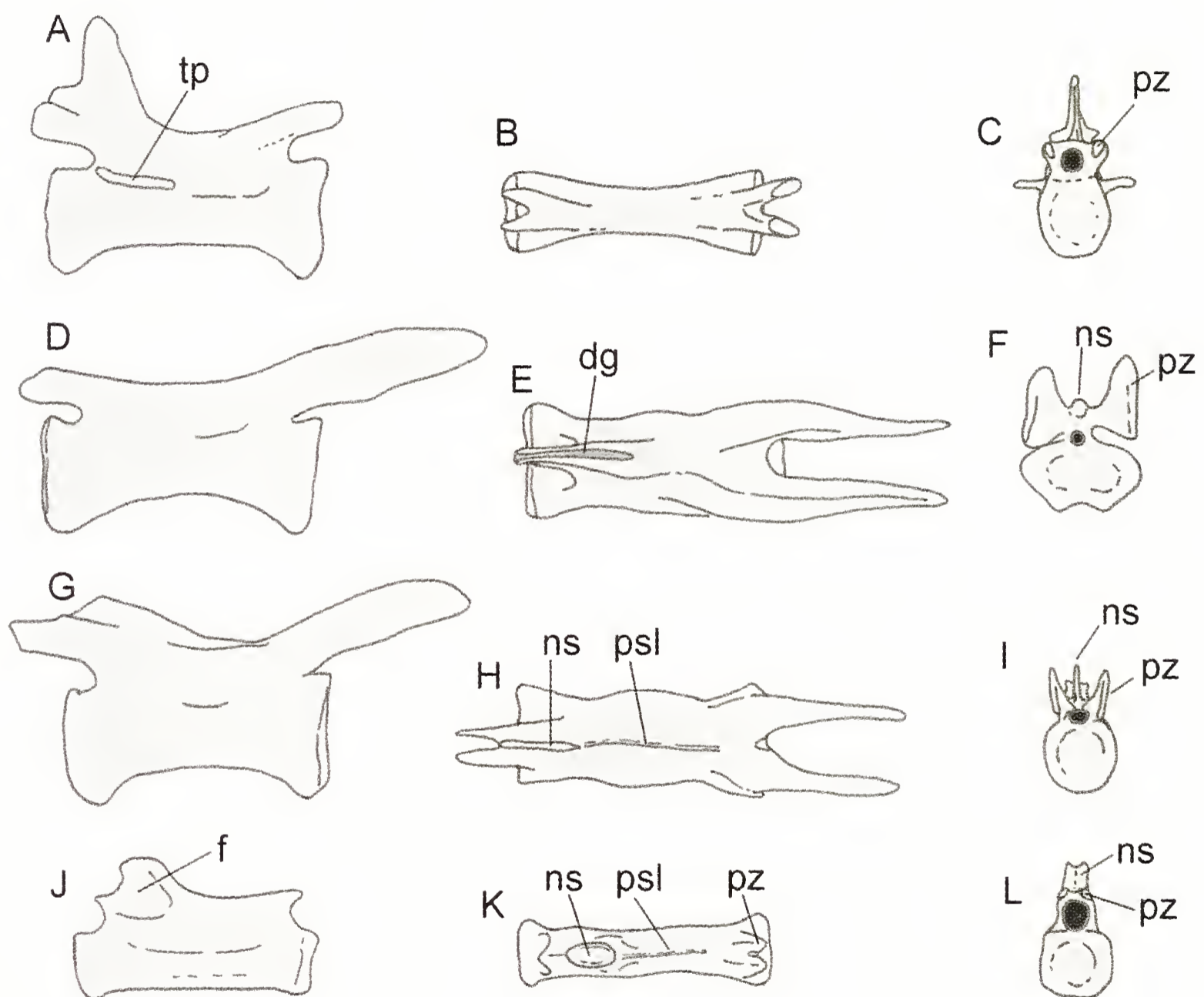
Fig. 3 - Theropod distal caudal vertebrae, in right lateral view (A, D, G, J), dorsal view (B, E, H, K), and proximal view (C, F, I, L): A, C, *Dilophosaurus* (modified from Welles, 1984); B, *Coelophysis* (modified from Colbert, 1989); D, E, *Allosaurus* (modified from Madsen, 1976); F, Ornithomimidae indet. (modified from Longrich, 2008); G-I, *Majungasaurus* (modified from O'Connor, 2007); J-L, MSNM V6408 (this study). Abbreviations: dg, dorsal groove; f, fossa; ns, neural spine; psl, prespinal lamina; pz, prezygapophyses; tp, transverse process. Not shown at the same scale. (Drawing by AC).
Fig. 3 - Vertebre distali di teropodi, nelle norme laterale destra (A, D, G, J), dorsale (B, E, H, K), e prossimale (C, F, I, L): A, C, *Dilophosaurus* (modificato da Welles, 1984); B, *Coelophysis* (modificato da Colbert, 1989); D, E, caudale distale di *Allosaurus* (modificato da Madsen, 1976); F, Ornithomimidae indet. (modificato da Longrich, 2008); G-I, *Majungasaurus* (modificato da O'Connor, 2007); J-L, MSNM V6408 (questo studio). Abbreviazioni: dg, solco dorsale; f, fossa; ns, spina neurale; pz, prezigapofisi; tp, processo trasverso. Non alla stessa scala. (Disegno di AC).

Elongation of the centrum is a widespread feature of theropod distal caudals: it is present in most neotheropods with the exceptions including therizinosauroids more derived than *Falcarius* (Kirkland *et al.,* 2005), oviraptorosaurs more derived than *Protarchaeopteryx* (Senter, 2007), and short-tailed avialians (Chiappe *et al.,* 1999). When compared with other elongate neotheropod caudals, MSNM V6408 shows an unusual combination of features (Fig. 3). The ventral surface is flat and lacks the longitudinal keels and grooves reported in most (Carrano *et al.*, 2002; Rauhut, 2003) - but not all (Osmólska, 1996; Novas, 1997; Kirkland *et al.,* 1998; Barsbold *et al.*, 2000; Carrano *et al.*, 2002; Rauhut, 2003) - theropod caudals. The relatively large size of the neural canal relative to the centrum suggests that this vertebra was not positioned very close to the distal end of the tail (Suzuki *et al.,* 2002; Brochu, 2003).

Size, robustness, and the shape of the neural processes (neural spine, transverse processes and zygapophyses) varies according to the position along the caudal series, and also varies among the different theropod clades.

Neural spine - The neural spine is relatively robust and differs from both the elongate sheet-like spines and the low ridge-like spines present in most theropod middle and distal caudals, being more similar to the robust rod-like middle caudal neural spines of some ceratosaurs (Carrano & Sampson, 2008; Madsen & Welles, 2000; Rauhut, 2003). In particular, the presence of a concave dorsal surface to the neural spine is shared with some mid-caudals of *Ceratosaurus* (Madsen & Welles, 2000). Among neotheropods, the position of the last caudal vertebra bearing a distinct neural spine is variable, and is not necessarily related to the total number of caudal vertebrae. In *Dilophosaurus* the 22nd caudal vertebra is the last one bearing a neural spine (Welles, 1984); in *Allosaurus* it occurs between the 35th and the 38th position (Madsen, 1976); in *Tyrannosaurus* the neural spines reduce after the 13th and the last one is at the 27th position (Brochu, 2003); in *Harpymimus* (Kobayashi, 2004) and *Nomingia* (Barsbold *et al.*, 2000) the neural spines become low crests after the 15th position; in *Sinosauropteryx*, which has the highest known number of caudals (Rauhut, 2003), the neural spines reduce after the 10th position and disappear at the 18th (Currie & Chen, 2001); whereas in paravians there are usually no more than 9 proximal caudals bearing distinct neural spines (Ostrom, 1969; Forster *et al.,* 1998; Mayr *et al.,* 2007).

Transverse processes - The absence of transverse processes shows that MSNM V6408 must have come from the part of the tail distal to the transition point (Russell, 1972; Gauthier, 1986; Tykoski, 2005). The position of the transition point is variable along theropod tails: it is, for example, more proximally located in those taxa closest to birds (Gatesy, 1990). Therefore, the proximal-most position possible for MSNM V6408, based on the absence of transverse processes, varies according to whichever clade it is compared with. In non-tetanuran theropods (Gilmore, 1920) the transition point occurs after the 30th position; in non-coelurosaurian tetanurans (Gilmore, 1920; Madsen, 1976) it occurs after the 25th position; in most coelurosaurs (with the exception of oviraptorosaurs, Barsbold *et al.*, 2000) it occurs at the 12-17th position (Russell, 1972); while in basal paravians it occurs more proximally (Gatesy, 1990; Rauhut, 2003; Turner *et al.,* 2007).

Zygapophyses - In most neotheropod clades, such as abelisauroids (e.g., O'Connor, 2007, but see Novas *et al.*, 2004), basal tetanurans (Madsen, 1976; Allain & Chure, 2002), basal coelurosaurs (Carpenter *et al.,* 2005) including tyrannosaurids (Brochu, 2003), ornithomimosaurs (Kobayashi, 2004), and dromaeosaurids

(Ostrom, 1969; Kirkland *et al.,* 1993; Norell & Makovichy, 1999), those prezygapophyses that occur distal to the transition point are very prominent and elongate, and reduce only in the distal-most vertebrae where the neural spine is completely absent. MSNM V6408 shows the opposite condition: the neural spine is short and low but robust, while the zygapophyses are reduced.

By analogy with the position of the transition point, the position of the first caudal bearing coalesced postzygapophyses varies among theropods, showing a trend toward a more proximal position in more bird-like theropods: in the non-tetanurans *Elaphrosaurus* and *Coelophysis* the fusion of the postzygapophyses occurs in the distal-most caudal vertebrae (Janensch, 1925; Colbert, 1989); in the non-coelurosaurian tetanuran *Allosaurus* it occurs distal to the 48th caudal (Madsen, 1976); in the basal coelurosaur *Tyrannosaurus*, distal to the 32th position (Brochu, 2003); in the maniraptoriform *Harpymimus* it occurs at the level of the 22nd caudal (Kobayashi, 2004); in the dromaeosaurid maniraptoran *Velociraptor*, it occurs distal to the 24th caudal (Norell & Makovichy, 1999); and in the oviraptorosaurian maniraptorans IGM 100/42 and *Nomingia* it occurs, respectively, at the 16th and 14th caudal (Auditore, pers. comm., 2008; Barsbold *et al.*, 2000). Interestingly, the condition among abelisauroids is more variable: in some forms the coalescence of the postzygapophyses occurs in the distal caudals, after the reduction or loss of both neural spines and transverse processes (*Majungasaurus* O'Connor, 2007; *Masiakasaurus*, Carrano *et al.*, 2002), whereas in others it occurs in the middle caudals (*Ilokelesia*, Coria & Salgado, 2000; *Ligabueino*, Bonaparte, 1996). The Moroccan specimen is similar to *Ilokelesia* in that a robust neural spine is present in the same part of the tail as are coalesced postzygapophyses. Compared with the reduction of the neural spines, we hypothesise that the coalescence of postzygapophyses in the tail of *Kemkemia* started in a more proximal position compared to the tails of, for example, *Majungasaurus*, *Masiakasaurus*, *Allosaurus*, *Tyrannosaurus* and *Harpymimus*.

MSNM 6408 differs from coelophysid distal caudals in the relatively less elongate centra and in the presence of spinal laminae (Wilson *et al.*, 2003, Appendix), and from *Dilophosaurus* and several basal (non-coelurosaurian) tetanurans in the shape and robustness of the neural spine and in the relatively less elongate prezygapophyses (Madsen, 1976; Rauhut, 2003; Welles, 1984). It differs from the distal caudals of most coelurosaurs in the presence of a robust neural spine (Brochu, 2003; Currie & Chen, 2001; Kobayashi, 2004; Ostrom, 1969), and from oviraptorosaurs in the relatively narrower and more elongate centrum (Makovicky & Sues, 1998; Barsbold *et al.*, 2000). Among known theropod middle and distal caudals, the combination of features observed in MSNM V6408 resembles that of some ceratosaur middle and distal caudals: namely, the caudal vertebrae have transversely wide neural spines (Coria & Salgado, 2000: fig. 9A; Madsen & Welles, 2000; Novas *et al.*, 2004; O'Connor, 2007), and possess distinct neural spines and coalesced postzygapophyses (Bonaparte, 1996; Coria & Salgado, 2000). However, we note that *Kemkemia* differs markedly from the distal caudals of the only two abelisauroids where such elements are well described (i.e., *Masiakasaurus* and *Majungasaurus*, Carrano *et al.*, 2002; O'Connor, 2007) in the development of both a neural spine and prezygapophyses. Novas *et al.* (2004) reported two morphologies of distal caudal vertebrae in the theropod material from the Lameta Formation (Maastricthian) of India (Huene & Matley, 1933). Both morphologies share similar elongation, but differ in the development of the vertebral processes: the

first, including caudals that bear elongate prezygapophyses and well developed "alariform" transverse processes, resembles *Masiakasaurus* (Novas *et al.*, 2004: 87) and *Majungasaurus* (O'Connor, 2007); the second, with robust neural spines, very short prezygapophyses and nearly absent transverse processes (Novas *et al.*, 2004; fig. 22), is very similar to *Kemkemia*. We note that one of these specimens (GSI K27-599, Huene & Matley, 1933, Plate XXIII, Fig.4) shows a morphology intermediate between MSNM V6408 and that seen in the abelisauroids *Ligabueino* and *Masiakasaurus*: hypertrophied neural canals are present, as are peculiar alariform transverse processes with dorsal excavations (Novas *et al.*, 2004). Compared with the Indian caudals, MSNM V6408 is relatively more elongate and narrow, and shows narrower and more reduced prezygapophyses, a taller neural arch and a neural spine that is relatively more prominent and robust. Whereas the former two features may indicate that the Moroccan specimen was positioned more distally along the tail than were the Indian ones, the prezygapophyseal and neural spine characters are interpreted as autapomorphic conditions useful in distinguishing *Kemkemia* from the Lameta forms. These data suggest the existence of a previously unknown lineage of theropods differing from other taxa in the presence of elongate distal caudals bearing transversely robust neural spines and very reduced prezygapophyses.

In conclusion, although the presence of some derived features suggests that MSNM V6408 may belong to the ceratosaurian lineage, we provisionally refer *Kemkemia auditorei* to Neotheropoda *incertae sedis*, pending the discovery of more complete material.

Comparison between *Kemkemia* and the theropod fossil record from the Kem Kem Beds - Based on comparison with several neotheropods (Gilmore, 1920; Janensch, 1925; Madsen, 1976; Welles, 1984; O'Connor, 2007), we estimate that the body size of *Kemkemia* was comparable to that of *Dilophosaurus* and *Elaphrosaurus* (Fig. 4). Although three theropod genera have been found in the Kem Kem Beds - *Carcharodontosaurus*, *Spinosaurus* and *Deltadromeus* (Russell, 1996; Sereno *et al.*, 1996) - only the distal caudal vertebrae of the latter are known. Following Novas *et al.* (2005), we do not consider *Sigilmassasaurus* (Russell, 1996) a junior synonym of *Carcharodontosaurus* (but see Sereno *et al.*, 1996; and Brusatte & Sereno, 2007; for a different interpretation of their synonymy). Our conclusion is based on two evidences: 1) Russell (1996) referred a partial cervical vertebra, NMC 50792, to *Carcharodontosaurus*, noting its similarities with a cervical vertebra referred by Stromer to the latter genus (Stromer, 1931: 11-12, pl. I, fig. 9). We concur with that identification, noting that NMC 50792 shares three carcharodontosaurid apomorphies: a hyposphene-like process ventral to the postzygapophyses (Russell, 1996: fig. 16b; Coria & Currie, 2006); a pneumatic fossa bearing multiple foramina on centrum (Russell, 1996: fig. 16c; Harris, 1998; Brusatte & Sereno, 2008); and a pair of large peduncular fossae between the neural canal and the prezygapophyses (Russell, 1996: fig. 16d; Harris, 1998; Novas *et al.*, 2005b). 2) The holotypic and referred cervical vertebrae of *Sigilmassasaurus* (Russell, 1996) lack the character conditions cited above, retaining the non-carcharodontosaurid plesiomorphies (single pleurocoelic fossa lacking multiple foramina; absence of hyposphene-like process; absence of peduncular fossae). If the presacral vertebrae of the "*Sigilmassasaurus* morphotype" would belong to *Carcharodontosaurus* (Sereno *et al.*, 1996; Brusatte & Sereno, 2007), then NMC 50792, from the same beds, should be referred to a new and distinct theropod, clearly belonging to the

carcharodontosaurid lineage. Based on cranial and dental data, there is no evidence that more than one carcharodontosaurid species co-occurred in the Kem Kem Beds (Brusatte & Sereno, 2007), nor in other Cretaceous North African localities (Sereno & Brusatte, 2008). Therefore, given that the "*Sigilmassasaurus* morphotype" lacks many of the carcharodontosaurid features present in NMC 50792, the most parsimonious explanation of the evidence is to refer the latter to *Carcharodontosaurus saharicus*, and to consider *Sigilmassasaurus brevicollis* a distinct species of dinosaur. Regardless to the taxonomic status of *Sigilmassasaurus*, its referred distal caudal vertebrae from the Kem Kem Beds (Russell, 1998) are clearly distinct from MSNM V6408 in shape and elongation of both centrum and postzygapophyses.

No distal caudal vertebrae of *Spinosaurus* and *Carcharodontosaurus* are known up to today. We cannot completely dismiss the hypothesis that MSNM V6408 belongs to one of these tetanurans. Nevertheless, based on comparison with their closest relatives, the most parsimonious hypothesis is that the distal caudals of these theropods should be similar to those of other basal tetanurans (Madsen, 1976; Allain & Chure, 2002; Coria & Currie, 2006) and, as a consequence, should be clearly different from MSNM V6408. We note that all known tetanurans share marked reduction of the neural spines on the distal caudals (Madsen, 1976; Allain & Chure, 2002; Brochu, 2003; Coria & Currie, 2006): as stated above, the most parsimonious interpretation is to consider *Kemkemia* a non-tetanuran neotheropod.

Deltadromeus is a large-bodied theropod from the same stratigraphic beds as *Kemkemia* (Sereno *et al.,* 1996). Initially referred to Coelurosauria (Sereno *et al.,* 1996; Rauhut, 2003), it is now considered to be a ceratosaur (Sereno *et al.,* 2004; Carrano & Sampson, 2008). Regardless of the phylogenetic position of *Deltadromeus*, its distal caudals differ from those of *Kemkemia* in lacking the marked

Fig. 4 - Estimated size of *Kemkemia* gen. nov. compared with *Homo* (1.74 m tall) and the largest known individuals of some of the other theropod genera recovered from the Kem Kem Beds: from left to right, *Spinosaurus* (based on Dal Sasso *et al.*, 2005), *Carcharodontosaurus* (Sereno *et al.*, 1996; modified from a drawing by Marco Auditore), *Deltadromeus* (modified from Sereno *et al.*, 1996), *Kemkemia* (this study; silhouette based on several basal neotheropods). (Drawing by AC).

Fig. 4 - Taglia stimata di *Kemkemia* gen. nov. comparata con *Homo* (altezza 1,74 m) e con gli individui più grandi di alcuni degli altri generi di teropodi rinvenuti nei letti del Kem Kem: da sinistra a destra, *Spinosaurus* (basato su Dal Sasso *et al.*, 2005), *Carcharodontosaurus* (Sereno *et al.*, 1996, modificato da un disegno di Marco Auditore), *Deltadromeus* (modificato da Sereno *et al.*, 1996) e *Kemkemia* (questo studio, sagoma basata su alcuni neoteropodi basali). (Disegno di AC).

mediolateral compression of the latter (in *Deltadromeus* the minimum diameter of the vertebra is 27% of vertebral length, whereas in *Kemkemia* it is 13%, Sereno *et al.*, 1996, Table 1), and in having more prominent prezygapophyses that overlap at least 40% of the preceding centrum (Wilson *et al.*, 2003, Appendix).

Among the other theropod remains from the Cenomanian of Morocco, two caudal vertebrae from Tafilalt have also been reported (NMC 41863 and NMC 50797, "Bone Taxon B" of Russell, 1996: 378). They differ from MSNM V6408 in the stronger development of their zygapophyseal bases, in the shape of the neural spine, and in the presence of a relatively narrower neural canal.

In recent years, some isolated theropod remains from the Kem Kem Beds have been referred to Abelisauridae (Russell, 1996; Mahler, 2005; Carrano & Sampson, 2008). UCPC 10 is a maxillary fragment found in the Kem Kem Beds (Mahler, 2005). It exhibits several abelisaurid apomorphies, including a textured lateral surface, *lamina lateralis* and *medialis* of subequal depth, deep fused paradental laminae, and subrectangular alveoli (Sereno *et al.*, 2004; Carrano & Sampson, 2008), but appears less derived than the maxillae of most abelisaurids in having faint shallow striations along the medial surface of the paradental plates instead of more furrowed plates (Carrano & Sampson, 2008). Nevertheless, as observed in carcharodontosaurids (Coria & Currie, 2006), the development of both lateral striations and medial paradental furrows may be ontogenetically controlled, so UCPC 10 may not have been fully grown at the time of death. Given that most of these features occurs homoplastically in derived carcharodontosaurids (Brusatte & Sereno, 2007), some authors have questioned the abelisaurid affinities of UCPC 10 (Carrano & Sampson, 2008). Nevertheless, this specimen shows further abelisaurid features (Sereno & Brusatte, 2008): a subvertical rostral end of the rostral ramus, a rostro-medially directed premaxillary facet, and a row of foramina located immediately above the alveolar border. Furthermore, it differs from carcharodontosaurid maxillae as these possess a caudodorsally inclined rostral ramus, a rostrally directed premaxillary facet, and a row of ventral foramina that are located more dorsally (Brusatte & Sereno, 2008). We therefore support Mahler's (2005) interpretation and regard UCPC 10 as an abelisaurid maxilla. Based on comparison with *Majungasaurus* (Sampson & Krause, 2007), we estimate that UCPC 10 belonged to an individual about 5.5 meters long.

NMC 50807 and NMC 50808 are two skull roof fragments from Tafilalt (Russell, 1996). Although Russell (1996) considered them "Theropoda indet.", Carrano & Sampson (2008) noted that they show neoceratosaurian apomorphies, including frontals that are fused and bear a sloped and striated nasal contact, and a sagittal parietal crest between the supratemporal fenestrae. We also note that NMC 50808 lacks an extensive ossification of the interorbital region (Russell, 1996: fig. 18), a derived feature shared by *Ceratosaurus* and abelisaurids (Carrano & Sampson, 2008: 224). These data may indicate that NMC 50807 and NMC 50808 belong to a basal (non-abelisaurid) neoceratosaur such as *Deltadromeus* (following the phylogenetic interpretation of that taxon favoured by Carrano & Sampson, 2008).

NMC 41589 and NMC 41861 are two fragmentary dentary rami from Tafilalt (Russell, 1996). They have been referred to Abelisauridae on the basis of the massively constructed lateral surface marked with indistinct vertical ridges, a marked craniomedial curvature of the alveolar margin, subrectangular alveoli, and fused paradental laminae. Although these features have a broader distribution among Theropoda (Carrano & Sampson, 2008), being also present in carcharodontosau-

rids (Brusatte & Sereno, 2008), we note that NMC 41589 shares with the abelisaurids *Carnotaurus*, *Majungasaurus* and *Ekrixinatosaurus* the presence of the lateral groove on the bone's ventral half (Carrano & Sampson, 2008: 226). Based on comparison with *Majungasaurus* (Sampson & Krause, 2007), we estimate that NMC 41589 belonged to a individual about 7-9 meters long.

These data indicate that at least one abelisaurid species is present in the Kem Kem Beds. While we note some resemblance between MSNM V6408 and the mid- and distal caudals of some abelisauroid taxa (see above), we cannot unambiguously refer any of the abelisaurid specimens from the Kem Kem Beds to *Kemkemia*.

We propose that more than three genera of middle- to large-sized theropods lived sympatrically in the Cenomanian of Morocco: the spinosauroid *Spinosaurus*, the allosauroid *Carcharodontosaurus*, the non-abelisaurid ceratosaur *Deltadromeus*, *Kemkemia* and (if further evidence will support the taxonomic distinction from *Kemkemia*) a yet-unnamed abelisaurid. The high diversity of middle- to large-sized carnivorous dinosaurs in the Kem Kem Beds recalls that found in other Mesozoic formations (e.g., the Morrison Formation, Weishampel *et al.*, 2004; or the Wealdien Supergroup, Brusatte *et al.*, 2008). Nevertheless, it is unusual in contrasting with the relatively lower diversity of local herbivores (Russell, 1996; Sereno *et al.*, 1996; Mahler, 2005) and may indicate either that there is a high under-sampling of local herbivores or the evolution of some intense form of competition and/or niche partitioning among the carnivores (Holtz, pers. com., 2008). Large fish are extremely abundant in the Kem Kem Beds (Sereno *et al.*, 1996; Naish, pers. comm., 2009). It is possible that this resource helps explain the diversity and number of predatory dinosaurs in the assemblage. By virtue of their simple digestive system and adaptability, carnivorous taxa can survive in poor environments where resources are few and far between. A similar phenomenon occurs in the Santana Formation of Brazil, where several theropod taxa are known, but no ornithischians or sauropodomorphs (Naish *et al.*, 2004).

Functional implications - In MSNM V6408, the presence of strongly reduced zygapophyses lacking articular surfaces shows that the intervertebral movement along the tail of *Kemkemia* was relatively more extensive than that of most theropods, whose tails are stiffened by overlapping zygapophyses. The presence of robust neural spines bearing pre- and postspinal laminae probably indicates that the epaxial musculature and interspinal ligaments compensated for the absence of zygapophyseal articulation between the neural arches. In particular, the concave dorsal surface of the neural spine may imply the presence of a continuous ligament linking the caudal vertebrae that helped in raising the tail following ventroflexion (Wedel *et al.*, 2000).

Conclusions

While based only on a single vertebra, *Kemkemia auditorei* shows a unique and unusual combination of features that distinguishes it from all other saurischian caudal vertebrae. Other saurischian species have been diagnosed on the basis of very fragmentary vertebral specimens (e.g., Carvalho *et al.*, 2003) if not on single vertebrae (e.g., Apesteguía, 2007; Taylor & Naish, 2007), or have been suggested on the basis of isolated bones (Longrich, 2008). Interestingly, other fossil taxa based on remains more complete than MSNM V6408 have been defined on a comparable list of vertebral diagnostic features (e.g., *Spinostropheus gautieri* Sereno

et al., 2004; and *Lophostropheus airelensis* Ezcurra & Cuny, 2007). Some authors have been reluctant to name new species on the basis of very fragmentary remains, noting that these specimens may be unique when first found, but later shown to be indeterminate as further discoveries reveal their distinctive features to characterize a clade rather than a single species (Longrich, 2008). Wilson & Upchurch (2003) termed this phenomenon "character obsolescence". We note that this phenomenon is not unique to fragmentary remains: it is instead a feature of almost all palaeontological species given that they are defined on the basis of a list of autapomorphic characters whose taxonomic distribution broadens once new relevant discoveries are made (Sues, 1998). As noted elsewhere (Taylor & Naish, 2007), the number of recognizable autapomorphies is the most valid criterion for the erection of a new taxonomic name. In our opinion, the naming of autapomorphy-bearing taxa is important - even when the remains are extremely fragmentary - because named taxa get noticed by the community at large, whereas unnamed ones - even if noted by authors as representing possible or potential new taxa - do not. We concur with Naish & Martill (2007) that "naming taxa, even those based on fragmentary remains, can be a useful exercise simply because named taxa are incorporated into large-scale studies of systematics and diversity. Unnamed taxa, even those thought to represent new species, generally are not" (Naish & Martill 2007: 506). MSNM V6408 is unique among theropod distal caudal vertebrae in both its presence of autapomorphic conditions (inflated neural canal, strongly reduced prezygapophyses, very broad naural spine, presence of shallow spinal fossae and transversely concave dorsal surface of the neural spine), and its unusual combination of features (simultaneous presence of reduced zygapophyses and robust neural spine bearing pre- and postspinal laminae). Following Taylor & Naish (2007)'s criterion, *Kemkemia auditorei* is clearly distinct from other theropods and worthy of consideration as a valid taxon.

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I Rettili della Riserva Naturale "Macchia di Gattaceca e Macchia del Barco" (Lazio)*

Riassunto - Il contributo illustra la fauna a Rettili della riserva naturale regionale "Macchia di Gattaceca e Macchia del Barco", frammento boschivo a querceto misto e substrato calcareo del cosiddetto "arcipelago area cornicolana" a nord-est dell'area urbana di Roma. Sono state monitorate 10 specie, alcune delle quali di rilevante interesse conservazionistico: *Anguis fragilis*, *Elaphe quatuorlineata*, *Natrix tessellata*. Vengono effettuate comparazioni con la ricchezza di specie di altri comprensori e svolte considerazioni sulle zoocenosi di Rettili dell'area ai fini della adeguata conservazione e valorizzazione. Il completamento della rete ecologica dei Rettili nei territori a nord-est della campagna romana suggerisce di garantire la continuità ecologica tra le aree protette contigue "Nomentum", "Macchia di Gattaceca e Macchia del Barco" e "Parco Regionale Naturale dei Monti Lucretili", in particolare tra le ultime due, data la minore distanza e le analogie strutturali esemplificate dalla natura del substrato.

Parole chiave: Reptilia, Italia centrale, biodiversità, conservazione, reti ecologiche.

Abstract - The Reptiles of the Natural Reserve "Macchia di Gattaceca and Macchia del Barco".

A monitoring study on the Reptiles of the Natural Reserve "Macchia di Gattaceca and Macchia del Barco", a mixed oak grove on limestone rock in the "archipelago area cornicolana" fragmented area, north east of Rome, has been carried out. Ten species are reported among which *Anguis fragilis*, *Elaphe quatuorlineata* and *Natrix tessellata* are particularly interesting. A comparison between species richness of this and neighbouring areas together with considerations on the zoocenosis are stressed. The completion of the ecological network between the protected areas north-east of the Roman Countryside, "Nomentum", "Macchia di Gattaceca and Macchia del Barco" and "Parco Regionale Naturale dei Monti Lucretili", particularly the last two bordering areas with similar substratum, is discussed.

Key words: Reptilia, Central Italy, biodiversity, conservation, ecological network.

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Introduzione

Numerose ricerche hanno documentato distribuzione e diversità degli Anfibi e dei Rettili nel Lazio (Bologna *et al.*, 2000, 2007). Permangono tuttavia lacune conoscitive sui comprensori più interni ed isolati. La riserva naturale "Macchia di Gattaceca e Macchia del Barco", 1162,00 ha, si estende sul territorio dei comuni di Mentana (150 m, 42.02N 12.38E), Monterotondo (165 m, 42.03N 12.37E) e Sant'Angelo Romano (400 m, 42.02N 12.43E). Istituita con Legge Regionale del Lazio 29/97 e gestita dalla Provincia di Roma è, insieme ad altri comprensori a nord-est della capitale ("Nomentum", "Soratte"), uno dei frammenti forestali più estesi dell'"arcipelago area cornicolana" localizzati nella Campagna Romana e aree limitrofe (Battisti *et al.*, 2002).

Sulla base dei dati in nostro possesso non esiste un contributo complessivo sui Rettili dell'area, a parte eventuali segnalazioni contenute in lavori a carattere più generale (Bologna *et al.*, 2000, 2007). L'obiettivo di questo contributo consiste nel descrivere le caratteristiche di tale fauna, soprattutto ai fini della sua conservazione e valorizzazione.
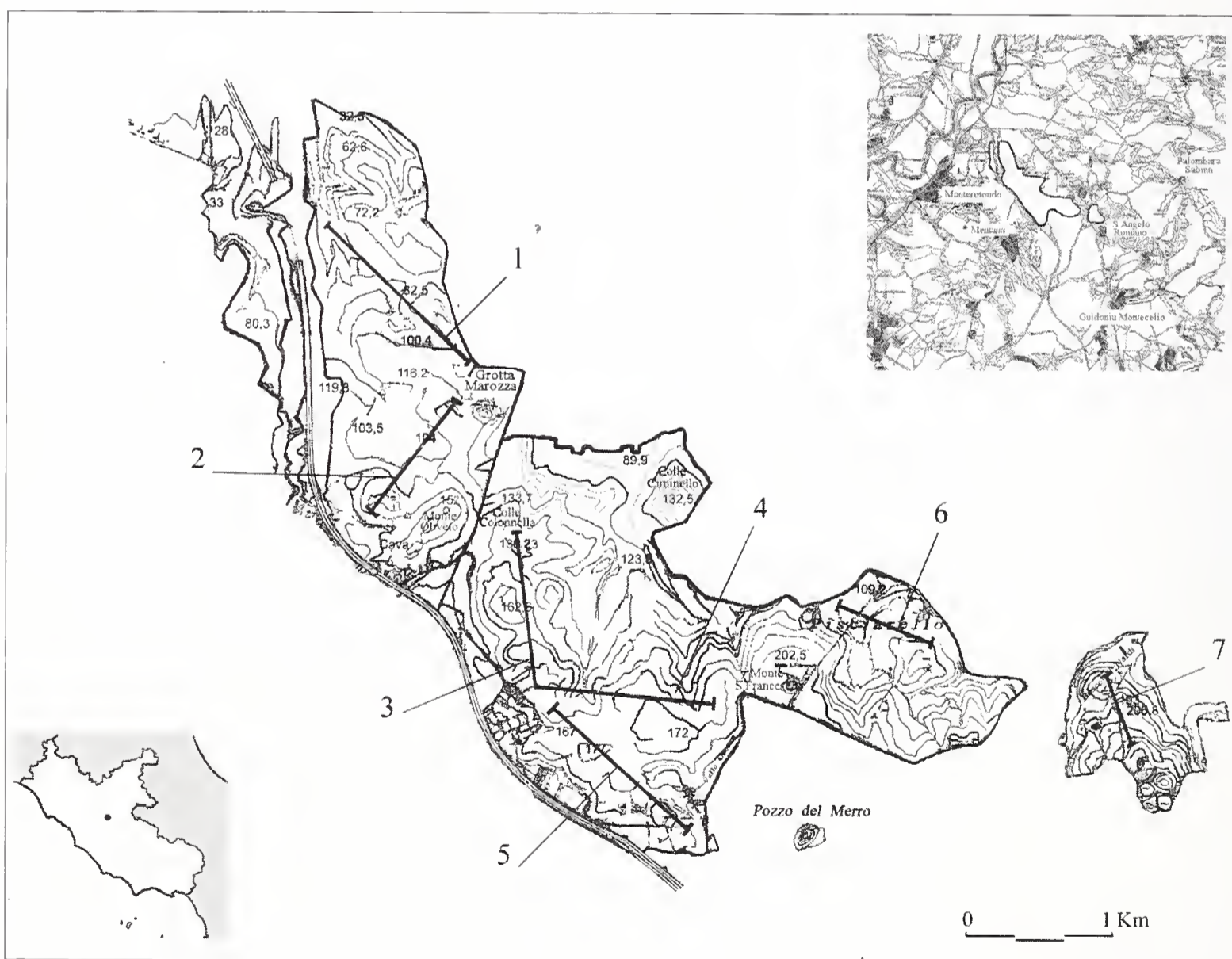
Fig. 1 - La "Macchia di Gattaceca e Macchia del Barco"; pianta dell'area, distribuzione e numerazione dei transetti. In basso a sinistra: posizione dell'area nel Lazio. In alto a destra: posizione dell'area nella Campagna Romana.

Fig. 1 - The "Macchia di Gattaceca and Macchia del Barco": map of the area, distribution and number of each transect line. Location of the area in Latium and the Roman Countryside.

Materiali e metodi

1) Area di studio. La riserva (d'ora in avanti "Macchia di Gattaceca") si inserisce in due sistemi territoriali strettamente connessi ed interdipendenti. Il primo è costituito dalla valle formata dalla riva sinistra del Fiume Tevere e dai sistemi montuosi dei Monti Cornicolani e dei Monti Lucretili. Il secondo è costituito dalle direttrici della ferrovia Roma - Firenze e dalle carrozzabili Salaria e Nomentana oltre che dal raccordo autostradale Fiano - San Cesareo. L'area della riserva (circa 8 km in linea d'aria NW-SE) presenta una morfologia dolcemente collinare, da 28 a 206,8 m s. l. m., con vaste plaghe destinate al pascolo ed all'uso agricolo (Fig. 1). Buona parte del territorio è di natura carbonatica con termini riferibili alla successione "umbro-sabina"; sono inoltre presenti terreni limoso-sabbioso-argillosi pliopleistocenici (Bortolani & Carugno, 1979). Nell'area è pure presente uno dei "sinkhole" più profondi del mondo, il Pozzo del Merro, nel comune di Sant'Angelo Romano, cavità imbutiforme perennemente allagata dalla falda carsica regionale di oltre 390 m di profondità (Giardini *et al.*, 2001). L'area della riserva, integralmente inclusa nella Regione Temperata di Transizione, è caratterizzata dal "Termotipo Collinare inferiore/superiore o Mesomediterraneo superiore; Ombrotipo umido inferiore; Regione mesaxerica (sottoregione ipomesaxerica)", al quale corrispondono: precipitazioni annuali tra 964 e 1166 mm; precipitazioni estive tra 103 e 163 mm; temperatura media annuale 14,2°C e temperatura media delle minime del mese più freddo -0,3°C; temperatura media mensile inferiore a 10°C per 4 mesi; aridità a luglio e agosto; stress da freddo intenso che si prolunga da ottobre a maggio. A questo termotipo corrisponde una vegetazione a querceti caducifogli con *Quercus cerris* e *Quercus pubescens* oltre a salici, pioppi e ontani (Blasi, 1994). Gli alberi guida del bosco appartengono a varie specie di *Quercus* e di *Carpinus* (*C. betulus*, *C. orientalis*), sono presenti inoltre *Acer campestre*, *Cercis siliquastrum*, *Fraxinus ornus*, *Sorbus torminalis*. Nel sottobosco predominano elementi tipicamente mediterranei: *Asparagus acutifolius*, *Rubia peregrina*, *Smilax aspera*. Gli arbusti guida che costituiscono il mantello ed il cespugliato sono rappresentati da *Clematis vitalba, Cornus sanguinea*, *Ligustrum vulgare*, *Mespilus germanica*, *Paliurus spina-christi*, *Pyracantha coccinea*, *Prunus spinosa*, *Rosa sempervirens*, *Spartium junceum*. Lo strato erbaceo è invaso dal pungitopo *Ruscus aculeatus* e da vistose fioriture di *Anemone* sp. (Battisti *et al.*, 2002). La "Macchia di Gattaceca" è attraversata da sentieri sterrati che costituiscono percorsi ciclabili, in particolare nel settore sud-occidentale limitrofo alla Via Reatina ove sono ubicati due ingressi con aree di sosta attrezzate. Il territorio della riserva è soggetto a vari fattori di disturbo con effetti negativi sulla presenza e consistenza di specie di interesse conservazionistico: discariche abusive, eccesso di fruizione turistica e di pascolo, bracconaggio, massiccia presenza di cinghiali, rimboschimenti inidonei, inquinamento delle acque profonde dovuto a scarichi di varia natura.

2) Metodologie di indagine. L'attività di monitoraggio è stata svolta da novembre 2003 a maggio 2008 per complessivi 40 sopralluoghi giornalieri sul campo effettuati esclusivamente in orario antimeridiano e pomeridiano e così ripartiti: 1 nel 2003, 6 nel 2004, 7 nel 2005, 9 nel 2006, 13 nel 2007, 4 nel 2008. La ripartizione mensile dei sopralluoghi è stata la seguente (mesi in numeri romani - sopralluoghi in numeri arabi): I - 2; II - 0; III - 4; IV - 7; V - 8; VI - 3; VII - 3; VIII - 3; IX -1; X - 5; XI - 3; XII - 1. Ai sopralluoghi partecipavano da 3 a 10 rilevatori. È stata adottata una delle più semplici tecniche di censimento per osservazione diretta, ovvero il metodo dei transetti che consiste nel seguire brevi percorsi lineari di lunghezza definita contando tutti gli individui osservati a sinistra e a destra del percorso. Sono stati prescelti

sette transetti, da 600 a 1500 m di lunghezza (valore medio 1100 m). La Fig. 1 evidenzia distribuzione e numerazione dei transetti. La Fig. 2 evidenzia la posizione della riserva nell'unità della griglia UTM a maglie quadrate di 10 km di lato (cf. Bologna *et al.*, 2000). La Fig. 3 illustra l'aspetto primaverile del sottobosco del comprensorio. Nel corso di ciascun sopralluogo venivano effettuate esplorazioni sistematiche del suolo e della vegetazione: alberi e arbusti; pareti di roccia, rupi, pavimento delle doline di crollo, microcavità; accumuli di pietre; muri di cinta e muretti a secco di edifici antropici. Ogni contatto visivo con specie dell'erpetofauna, esuvie e spoglie incluse, veniva trascritto sui protocolli di campagna. Alcuni cadaveri sono stati recuperati, fissati in alcool e depositati nella Collezione Vertebratologica della SRSN (CVSRSN) ove sono attualmente conservati. La manipolazione degli individui catturati avveniva per il tempo strettamente necessario, minimizzando i fattori di stress.

Risultati

Per la nomenclatura aggiornata dei taxa di Reptilia sono stati utilizzati Sindaco *et al.* (2006) e Sindaco & Jeremčenko (2008). L'ordine di citazione delle specie di Reptilia è quello adottato da Bologna *et al.* (2007). La distribuzione delle specie è basata sulle informazioni contenute in Bologna *et al.* (2000, 2003 e 2007) per il Lazio
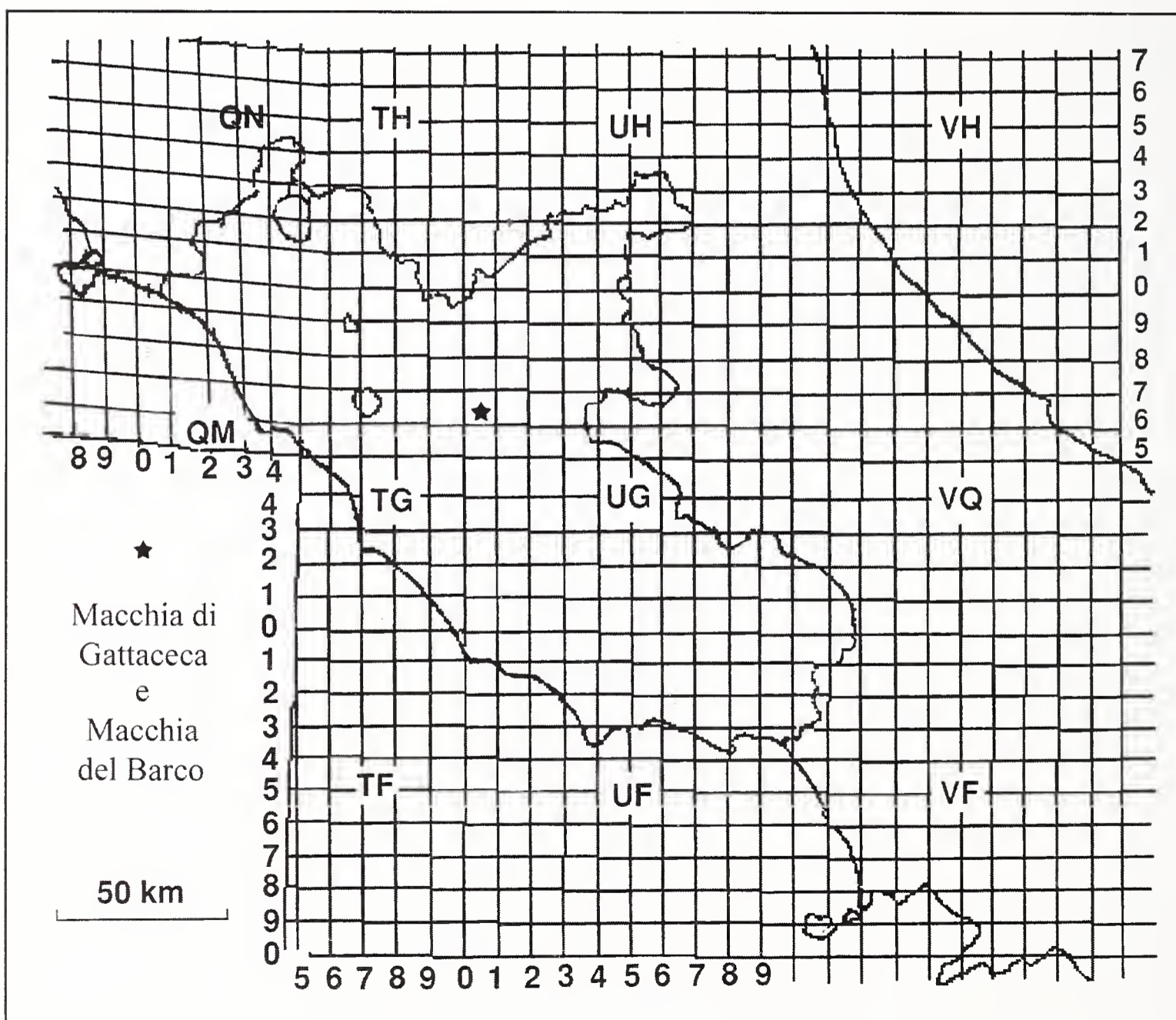
Fig. 2 - Posizione dell'area nel reticolato UTM del Lazio.
Fig. 2 - Location of the area in Latium UTM grid.

Fig. 3 - Aspetto primaverile del sottobosco (foto S. Buccedi).
Fig. 3 - Spring appearance of the understory (photo S. Buccedi).

e in Di Tizio *et al.* (2008) per l'Abruzzo. Ciascuno dei taxa viene citato con il nome scientifico, il nome comune italiano ed il nome vernacolare più frequentemente utilizzato nel Lazio. Il numero di sopralluoghi nel corso dei quali una specie è stata osservata è raffrontato al numero totale, ad esempio 4/40 ovvero quattro sopralluoghi su quaranta. Nel testo sono utilizzate le seguenti abbreviazioni: LT) lunghezza totale, dall'apice del muso all'estremità della coda, non rotta e non rigenerata nel caso di Lacertidae e Scincidae: LC) lunghezza della coda; Ex./exx.) individuo/i. I mesi dell'anno sono in numeri romani. La distribuzione e fenologia delle specie in rapporto ai transetti prescelti è sintetizzata in Tab. 1 e Tab. 2. Si presenta, a questo punto, l'elenco annotato delle specie della riserva.

Hemidactylus turcicus (Linnaeus, 1758)/Geco verrucoso/Salamandra

Si tratta dell'unica specie non raccolta né osservata dagli autori. La sua presenza nella riserva può tuttavia ritenersi certa in quanto individui con le caratteristiche di questa specie sono stati osservati dai locali, sulla base di testimonianze ottenute nell'agosto 2006, in due siti: i ruderi del fortilizio medievale in località Grotta Marozza e le abitazioni ubicate all'ingresso principale della riserva lungo la Via Reatina nei pressi dell'abitato di Mentana. D'altronde questa specie è presente nelle limitrofe riserve naturali regionali "Marcigliana" e "Nomentum" (Crucitti *et al.*, 2004, 2007) come pure nel "Parco Naturale Regionale dei Monti Lucretili" e sui Monti Cornicolani (Carpaneto, 1995). Comune e diffuso nel Lazio, incluso l'ecosistema urbano di Roma, questo geco è tuttavia assente nelle aree più interne come la Provincia di Rieti; in Abruzzo risulta localizzato. È considerata specie relativamente lucifuga, sinantropica e stenozonale.

Tab. 1 - Distribuzione e fenologia di tre specie di Lacertidae nella “Macchia di Gattaceca”. / Distribution and phenology of three species of Lacertidae in “Macchia di Gattaceca”.
■ *Lacerta bilineata* Δ *Podarcis muralis* ● *Podarcis siculus*

	Mese											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Transetto												
1						●	●Δ					
2					●	●	●					
3			●	■Δ●	■Δ●	■Δ●	■Δ●	■Δ●	Δ●	Δ●	●	●
4				■Δ●	■Δ●	■Δ●	■Δ●	■Δ●	Δ●	Δ●	●	●
5						●	●	●				
6						●	●	●				
7				●		Δ						

Tab. 2 - Distribuzione e fenologia di una specie di Anguidae e una specie di Scincidae nella “Macchia di Gattaceca”. / Distribution and phenology of one species of Anguidae and one species of Scincidae in “Macchia di Gattaceca”.
■ *Anguis fragilis* Δ *Chalcides chalcides*

	Mese											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Transetto												
1												
2					Δ	Δ						
3				■	■							
4				Δ	Δ	Δ						
5					Δ							
6												
7												

Anguis fragilis Linnaeus, 1758/Orbettino/Cecilia

4/40. Specie assai localizzata nel territorio della riserva. È stata osservata in un unico sito della località Macchia di Gattaceca *s. str.* nel settore sud-occidentale della riserva, nel corso di tre sopralluoghi successivi: 1 ex. di LT = 115 mm, 1 ex. di LT = 135 mm, 1 ex. di LT = 195 mm. Non è possibile stabilire se si tratta di

un unico individuo o di individui diversi, apparentemente sub-adulti. Il sito è una forra profonda e umida invasa da vegetazione relativamente fitta con grandi alberi allettati ricoperti da lianose e substrato di sfasciume calcareo. La specie è sempre stata rinvenuta sotto pietre nel settore più depresso della forra con temperatura a livello del suolo 10,4 - 14,7°C e sotto le pietre 12,0 - 15,3°C. Specie a distribuzione discontinua è comunque presente in tutte le province del Lazio; nell'ecosistema urbano di Roma appare assai localizzata. In Abruzzo è frequente soprattutto nel settore sud - orientale. La relativa scarsità di informazioni sulla distribuzione e biologia viene attribuita alle sue abitudini elusive e parzialmente fossorie. È considerata specie sostanzialmente igrofila ed eurizonale.

Lacerta bilineata Daudin, 1802/Ramarro occidentale/Ràgano

14/40. Specie ampiamente diffusa nella riserva ove frequenta il sottobosco, i prati erbosi, gli ecotoni tra prato e bosco e tra prato e arbustivo fitto a *Genista* sp. Individui adulti sono stati rinvenuti in marzo sotto grandi pietre in forre profonde. LT (n = 8): 120 - 405 mm. Temperatura di attività (11 misure): intervallo complessivo 18,2 - 29,0°C. Specie ampiamente diffusa in tutte le province del Lazio, presenta una distribuzione relativamente continua nel tessuto urbano di Roma, anche in Abruzzo risulta uniformemente diffusa. È considerata specie silvicola e piuttosto eurizonale.

Podarcis muralis (Laurenti, 1768)/Lucertola muraiola/Carbonara

23/40. Specie assai diffusa nella riserva ove risulta uno dei sauri più comuni. Si rinviene nel sottobosco, sotto grandi ceppi e alberi completamente allettati; nel cespugliato fitto; all'interno delle doline, al fondo e sulle pareti; nell'ecotono tra prato e bosco; nei muri di cinta di edifici antropici; sulle grandi rupi calcaree (La Cava). È pure presente nell'area circostante il Pozzo del Merro e nel Bosco di Nardi. Adulti sotto le pietre in dicembre; sub-adulti anche sotto le cortecce in aprile. LT (n = 8): 80 - 220 mm. Temperatura di attività (21 misure): intervallo complessivo 13,8 - 32,0°C. Comune e diffusa sia nel Lazio sia in Abruzzo ad eccezione delle aree planiziali ad agricoltura intensiva. È considerata specie piuttosto euriecia, silvicola ed eurizonale.

Podarcis siculus (Rafinesque, 1810)/Lucertola campestre/Lucertola

23/40. Specie assai diffusa, risulta tra le più comuni e abbondanti. Nella riserva si rinviene soprattutto nei prati erbosi, anche ingombri di rifiuti solidi urbani, nei prati cespugliati e nel sottobosco non troppo fitto e, in fase di termoregolazione, su affioramenti di roccia calcarea. In giugno sono stati osservati combattimenti rituali tra maschi adulti. Strettamente sintopica con *P. muralis* in particolare nel cespugliato fitto e nei muri di cinta delle abitazioni, risulta più antropotollerante della specie congenere. È pure presente in località Grotta Marozza, nell'area circostante il Pozzo del Merro e nel Bosco di Nardi. LT (n = 4): 140 - 210 mm. Temperatura di attività (16 misure): intervallo complessivo 16,4 - 36,0°C. Comune e diffusa sia nel Lazio sia in Abruzzo. È considerata specie euriecia, praticola e relativamente eurizonale.

Chalcides chalcides (Linnaeus, 1758)/Luscengola/Fienarola

11/40. Specie relativamente abbondante e diffusa. Nella riserva si rinviene soprattutto nei prati erbosi con radi arbusti su declivi assolati, nei siti disturbati dalle attività antropiche, nell'ecotono prato - cespugliato fitto e prato - bosco.

È stata tuttavia riscontrata nella sola Macchia di Gattaceca *s. str.* non essendo mai stata osservata nei siti di Grotta Marozza, Bosco di Nardi e Pozzo del Merro. LT (n = 19): 90 - 290 mm. Temperatura di attività (19 misure): intervallo complessivo 16,0 - 31,8°C. Ampiamente diffusa nel Lazio, incluso l'ambiente urbano di Roma ove risulta piuttosto comune; in Abruzzo è frequente soprattutto nel settore sud-occidentale. È considerata specie praticola e relativamente eurizonale.

Elaphe quatuorlineata (Lacépède, 1789)/Cervone/Pastoravacche

1/40. Apparentemente non comune. Un individuo di questa specie, femmina adulta di LT = 150 cm ed LC = 25,5 cm, è stato rinvenuto l'8/V/2005, h 15:50, in attività di termoregolazione, su un cespuglio di *Rubus* sp. all'ingresso di una microcavità profonda circa 150 cm, con pavimento tappezzato da frammenti di calcare ricoperti di muschio; temperatura dell'aria all'ingresso della nicchia 22,0°C e all'interno della nicchia 18,0°C. L'ambiente è costituito da un prato erboso con affioramenti di roccia calcarea su declivio assolato digradante verso la carrozzabile Fiano - San Cesareo. Specie diffusa su tutto il territorio del Lazio sebbene in progressiva rarefazione, è inoltre localizzata nell'area urbana di Roma. Anche in Abruzzo, la sua distribuzione si presenta discontinua soprattutto nelle aree più interne, mentre nella fascia costiera sub-collinare risulta ormai del tutto assente. È considerata specie silvicola e relativamente eurizonale.

Hierophis viridiflavus (Lacépède, 1789)/Biacco/Frustone

2/40. Specie sicuramente più diffusa trattandosi di uno dei serpenti più comuni e abbondanti nel Lazio e nell'Abruzzo, dal livello del mare al piano montano. Nel territorio della riserva, adulti e sub-adulti sono stati osservati in aprile e maggio, attivi ed in termoregolazione, soprattutto nei prati erbosi, nei declivi assolati ai margini del sottobosco, su pareti di roccia calcarea (La Cava). È considerata specie euriecia ed antropotollerante.

Natrix tessellata (Laurenti, 1768)/Natrice tassellata/Biscia d'acqua

1/40. Apparentemente rara e localizzata. Un giovane di questa specie è stato raccolto in località Tor Mancina nella Macchia del Barco, al margine nord - occidentale della riserva. Rinvenuto nei pressi di una abitazione privata, nei dintorni della quale è presente una piccola raccolta d'acqua, sotto una catasta di legname, è stato consegnato (IV.2006) cadavere agli autori. Questo esemplare è attualmente conservato nella CVSRSN n. 1002. Specie relativamente diffusa nel Lazio ove appare tuttavia in vistosa contrazione numerica, è assai localizzata nell'area urbana di Roma. In Abruzzo la sua distribuzione appare relativamente continua solo nei settori centrale e occidentale. La distribuzione, limitata alle aree planiziali ed alla fascia altimetrica più bassa del piano montano, suggerisce la qualifica di specie stenozonale.

Vipera aspis (Linnaeus, 1758)/Vipera comune/Aspide

3/40. Specie relativamente comune, nella riserva è probabilmente più diffusa di quanto sia possibile dedurre dalle osservazioni effettuate. Il 9/X/2005, un maschio sub-adulto (LT = 25 cm; LC = 3,5 cm) deambulava nel sito noto ai locali come "Piazza di Spagna", prato erboso adibito ad area di sosta attrezzata nei pressi dell'ingresso principale antistante la Via Reatina. L'individuo è stato raccolto alle h 13:00 (temperatura aria 13,0°C; temperatura substrato 16,0°C) nello scovolo di una

carbonaia in calcare. Il 14/X/2005, il cadavere di una femmina adulta (LT = 58 cm; LC = 9,0 cm) in ottime condizioni di conservazione, è stato rinvenuto ai margini della carrozzabile che collega la riserva all'abitato di Castel Chiodato. I due esemplari sono attualmente conservati nella CVSRSN, n. 989 e 991. Il 14/V/2006, sono stati rinvenuti nel sottobosco, all'altezza dell'ingresso principale di Via Reatina presso Mentana, i resti di un individuo costituiti da una porzione priva di 1/3 del corpo inclusa la testa. Trattandosi di un frammento integro e fresco di 53 cm (LC = 8,0 cm) se ne deduce una LT 75 - 80 cm del soggetto in vita. Le caratteristiche del frammento suggeriscono un episodio di predazione da parte del riccio *Erinaceus europaeus* o della donnola *Mustela nivalis*. *Vipera aspis* è pertanto presente in località assai frequentate della riserva. Tuttavia, a riscontro di un livello di rischio assai basso, si rileva l'assenza, nell'ultimo decennio, di incidenti di morsicatura e avvelenamento imputabili a questa specie. La vipera comune è piuttosto diffusa in tutto il territorio del Lazio mentre risulta localizzata nell'ambiente urbano di Roma. In Abruzzo è diffusa uniformemente con l'unica eccezione per la fascia planiziale costiera. È specie silvicola e sostanzialmente eurizonale con una marcata predilezione per il piano medio montano.

Discussione

La ricerca ha permesso di accertare l'esistenza, nel territorio dell'area protetta "Macchia di Gattaceca e Macchia del Barco", di 10 specie di Rettili ovvero 1 Gekkonidae, 1 Anguidae, 3 Lacertidae, 1 Scincidae, 3 Colubridae, 1 Viperidae. Nella limitrofa riserva regionale "Nomentum", Crucitti *et al.* (2004) sono stati in grado di accertare, nell'area limitata alla "Macchia Trentani" la presenza di 8 specie autoctone di Rettili ovvero 1 Gekkonidae, 1 Anguidae, 3 Lacertidae, 3 Colubridae. *Chalcides chalcides* e *Vipera aspis* sono state rinvenute esclusivamente nella Macchia di Gattaceca, al contrario di *Natrix natrix* (Linnaeus, 1758) o biscia dal collare e di *Zamenis longissimus* (Laurenti, 1768) o saettone comune, rinvenuti esclusivamente nella riserva "Nomentum". La presenza del geco comune *Tarentola mauritanica* (Linnaeus, 1758), specie ampiamente diffusa nel Lazio, potrebbe essere evidenziata da future ricerche. Si constata inoltre l'assenza degli ofidi del genere *Coronella*. Peraltro, il colubro liscio *Coronella austriaca* Laurenti, 1768, risulta più comune nelle zone collinari e montane del Lazio, mentre il colubro di Riccioli *Coronella girondica* (Daudin, 1803), della quale sono noti vecchi reperti della "Marcigliana" (Crucitti *et al.*, 2007), risulta uno dei serpenti più localizzati dell'Italia centrale ove appare in forte regresso. Sembra infine possibile escludere la presenza della testuggine di Hermann *Testudo hermanni* Gmelin, 1789 rinvenuta con pochi individui isolati nell'area romana, forse esemplari domestici abbandonati, nonché della testuggine d'acqua europea *Emys orbicularis* (Linnaeus, 1758) anch'essa localizzata e la cui presenza nella "Macchia di Gattaceca" può essere ritenuta poco probabile a causa della scarsità di acque superficiali. Analogamente, la scarsità di acque correnti in zone caratterizzate da forte carsismo influisce sulla capacità portante dell'ambiente nei confronti degli ofidi del genere *Natrix*, in particolare *N. tessellata*. La rarità di *Elaphe quatuorlineata* potrebbe essere invece imputata alla scarsità di habitat idonei non immediatamente riconducibili all'assenza di ambienti umidi. Al contrario, condizioni siccitose determinano verosimilmente situazioni favorevoli alla presenza di *Chalcides chalcides* e *Vipera aspis*. Nella riserva "Nomentum", a substrato costi-

tuito da sabbie argillificate, l'acqua è relativamente abbondante anche durante la stagione secca (Crucitti *et al.*, 2004). Le differenze, peraltro modeste, riscontrate nel popolamento a Rettili delle due aree non sembrano imputabili alla sola disponibilità dell'acqua, al contrario di quanto si verificherebbe per il popolamento ad Anfibi, assai più monotono nel caso della "Macchia di Gattaceca", appena 2 specie sinora accertate a riscontro delle 6 della riserva "Nomentum" (Crucitti *et al.*, 2004 e dati inediti). Nelle due aree sopra menzionate risulta certa la presenza complessiva di 12 specie di Rettili a riscontro delle 13 del "Parco Regionale Naturale dei Monti Lucretili", 16 dell'area urbana di Roma, 18 della Provincia di Roma, 21 del Lazio, 18 dell'Abruzzo, 22 dell'Appennino, 33 dell'Italia continentale (Bologna *et al.*, 2000, 2003, 2007; Carpaneto, 1995; Di Tizio *et al.*, 2008). Un importante contingente di specie risulta localizzato nella Macchia di Gattaceca *s. str.*, tra l'ingresso principale di Via Reatina, la carrozzabile Fiano - San Cesareo e le loro immediate adiacenze. In quest'area di pochi ettari si concentrano almeno sei specie, *P. muralis*, *P. siculus*, *L. bilineata*, *C. chalcides*, *E. quatuorlineata*, *V. aspis*, le prime quattro con popolazioni abbondanti. Si tratta di ambienti diversi e relative fasce di transizione: dirupi, prati erbosi con affioramenti di roccia calcarea su "terra rossa", prati digradanti su declivi assolati con manto erboso costituito da orchidee, composite ed euforbie, parcelle di coltivi abbandonati con vecchi ulivi, cespugliato fitto, bosco misto. L'area sopra menzionata sopporta la pressione del pascolo ovo-caprino e l'impatto del turismo stagionale. In particolare, nello spiazzo erboso adibito a luogo di sosta attrezzato e noto ai locali come "Piazza di Spagna", in posizione satellite rispetto ai siti circostanti ad elevata biodiversità, si riscontrano spesso comportamenti illeciti: accensione di fuochi, cani in libertà, prelievo di piante spontanee. Garantire la continuità ecologica tra le riserve "Nomentum", "Macchia di Gattaceca" ed il "Parco Regionale Naturale dei Monti Lucretili" significa implementare la rete ecologica interposta tra le aree limitrofe suddette. La minore distanza e la maggiore affinità, esemplificata dalla natura del substrato geologico, tra la "Macchia di Gattaceca" ed il "Parco Regionale Naturale dei Monti Lucretili" suggerisce la realizzazione di idonei collegamenti e corridoi tra le due aree. In ogni caso, ci sembra di poter concordare con le equilibrate conclusioni di una recente analisi: "...il completamento della rete ecologica dei rettili (così come per alcune altre classi) non si deve necessariamente ottenere con l'istituzione di altre aree protette, ma spesso è sufficiente assicurare l'idoneità ambientale attraverso normative e regolamenti sulle attività antropiche, pratiche agricole e uso di sostanze chimiche" (Boitani *et al.*, 2002).

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Note e Comunicazioni

Nicola Maio*, Nicola Marrone**, Fabio Giannetti** &
Fabio Maria Guarino***

Prima segnalazione di *Natrix tessellata* (Laurenti, 1768) nel Parco Regionale "Riviera di Ulisse" (Latina, Lazio)

Abstract - First record of *Natrix tessellata* (Laurenti, 1768) in the "Riviera di Ulisse" Regional Park (Latine, Latium).

Natrix tessellata, snake belonging to the family of Colubridae, has been recorded for the first time in the "Riviera di Ulisse" Regional Park, along Rio S. Croce (Municipality of Formia, Latina Province, Latium Region) at around 6 m a.s.l. This finding is interesting because data on the presence of this species were not available for the southern coast of Latium since 1980.

Key words: *Natrix tessellata*, Colubridae, first record, southern Latium.

Natrix tessellata (biscia tassellata) è un serpente prevalentemente acquatico appartenente alla famiglia Colubridae. Da adulto la lunghezza è compresa fra 60 e 130 cm, il dorso è di color grigio-bruno o bruno olivastro con bande scure trasversali a zig-zag che possono essere più o meno fuse, il ventre è bianco-giallastro, talvolta aranciato, con chiazze nere disposte irregolarmente. Caratteristica è la forma del capo, allungato ed allargato alla base; la pupilla è rotonda. L'areale di distribuzione della biscia tassellata si estende dalla Germania alla Cina nord-occidentale ma la specie è diffusa prevalentemente nella parte orientale dell'Europa orientale e Asia occidentale. In Italia è presente nella maggior parte del territorio peninsulare ed è assente nelle isole maggiori (Scali & Gentilli, 2006). Nel Lazio *N. tessellata* risulta abbastanza diffusa in tutto il territorio, ad eccezione delle zone montuose e di alcuni tratti costieri come quello relativo al medio e basso litorale della Provincia di Latina, per il quale dati sulla presenza di questa specie risalgono a prima

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del 1980 (Filippi, 2000). Nella presente nota viene segnalato per la prima volta il rinvenimento di alcuni individui di *N. tessellata* in località Rio S. Croce (Comune di Formia, Provincia di Latina), situato all'interno del Parco Regionale "Riviera di Ulisse". Tale sito ricade proprio in uno degli ambiti territoriali del Lazio dove la specie non era stata più segnalata nell'ultimo trentennio. Gli individui sono stati osservati, catturati, fotografati e rilasciati il 23 ottobre 2008 in un tratto lento del Rio Santa Croce, a 6 m sul livello del mare, in un contesto fortemente antropizzato come testimoniato dalle sponde a tratti cementificate, dalle microdiscariche di rifiuti ed inerti e da alcuni scarichi fognari di abitazioni. Nel tratto esaminato sono state osservate anche diverse specie di pesci (*Barbus tyberinus*, *Cyprinus carpio*, *Leuciscus cephalus*) e rane verdi, di cui non è stato possibile al momento determinare la specie, ma probabilmente attribuibili a *Pelophylax bergeri* e/o *Pelophylax* kl. *hispanica*, entrambe ampiamente diffuse nel territorio laziale. Al riguardo è utile ricordare che la dieta di *N. tassellata* è basata principalmente su pesci e secondariamente su anfibi allo stato adulto e giovanile.

La biscia tassellata è inserita nell'allegato II della Convenzione di Berna, nell'allegato D della Direttiva 92/43/CEE (nota anche come Direttiva Habitat) e nella Legge Regionale n. 18 del 05/04/88. Sebbene la specie sia relativamente diffusa nella regione Lazio, la presenza di questo ofidio non è omogenea ed è indirettamente minacciata da vari tipi di alterazione e degrado dell'habitat di origine antropica, come la regimentazione idraulica con distruzione della vegetazione ripariale, gli scarichi fognari, ecc., (Filippi, 2000). Ulteriori ricerche sono in corso per definire lo status di *N. tessellata* non solo nel tratto costiero meridionale laziale, ma anche in quello campano, limitrofo, per il quale si dispone di poche e datate segnalazioni su questa specie (Caputo & Guarino, 1993).

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Giorgio Baldizzone

Contribuzioni alla conoscenza dei Coleophoridae. CXX. Sulla identità di *Coleophora tuscaemiliella* Costantini, 1923 (Lepidoptera: Coleophoridae)

Abstract - Contributions to the knowledge of Coleophoridae. CXX. On the identity of *Coleophora tuscaemiliella* Costantini, 1923 (Lepidoptera: Coleophoridae).

This paper deals with the true identity of *Coleophora tuscaemiliella* Costantini, 1923, which was so far considered as a doubtful species. The examination of the holotype, preserved at the Museo di Storia Naturale of Milan, allowed to establish the new synonymy: *Coleophora alcyonipennella* (Kollar, 1832) = *C. tuscaemiliella* Costantini, 1923.

Key words: Lepidoptera, Coleophoridae, *Coleophora tuscaemiliella*, *Coleophora alcyonipennella*, new synonimy.

Coleophora tuscaemiliella Costantini, 1923 venne descritta sulla base di un esemplare maschio raccolto da Attilio Fiori il 20.VII.1920 a Mandriole, frazione di Fiumalbo, nell'Appennino emiliano. La descrizione originale, redatta in latino, riguardava una specie con le ali anteriori di color bronzo a riflessi cupreo-violacei, con antenne di uniforme color bronzo ad apice bianco. Con questo *habitus* però, si presentano diverse specie del gruppo di *Coleophora trifolii* (Curtis, 1832) che spesso richiedono l'esame dell'armatura genitale per una sicura identificazione.

Essendo stato raccolto da Fiori, era logico pensare che l'olotipo si trovasse nella sua collezione. Quest'ultima è conservata presso il Museo di Storia Naturale di Milano che visitai nel 1976-77 per studiare tutti i Coleophoridae e poi pubblicarne la lista commentata (Baldizzone, 1979a). Non trovai però l'olotipo di *C. tuscaemiliella*, ma solo alcuni esemplari raccolti successivamente da Fiori nell'Appennino modenese e da lui etichettati con questo nome. L'esame dei genitali rivelò che si trattava di *Coleophora mayrella* (Hübner, 1813) che all'epoca della mia pubblicazione era ancora conosciuta con il nome di *C. spissicornis* (Haworth, 1828). Cercai quindi di ottenere informazioni sull'esistenza di una collezione Costantini in cui cercare l'esemplare, ma senza successo, per cui, sulla base del nuovo materiale identificato da Fiori, decisi di porre in sinonimia *tuscaemiliella* con *mayrella* (= *spissicornis*), pur trovando una discrepanza tra le antenne di *mayrella*, che sono

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anellate di bianco e di bronzo scuro, e quelle di *tuscaemiliella*, descritte come uniformi. La nuova sinonimia venne pubblicata (Baldizzone, 1979b) ma purtroppo, nel testo, per uno strano *lapsus calami*, invece di scrivere *Coleophora spissicornis* (Haworth, 1828), scrissi *Coleophora fuscicornis* (Haworth, 1828), mentre nel riepilogo finale indicai correttamente *Coleophora spissicornis* (Haworth, 1828) = *Coleophora tuscaemiliella* Costantini, 1923.

Questa sinonimia venne accettata e riportata nel World Catalogue dei Coleophoridae (Baldizzone *et al.*, 2006), ma fu poi messa in discussione nel corso di un lavoro di revisione del gruppo di *C. frischella* (Stübner, 2007). Sulla base della descrizione di Costantini, Stübner affermava che l'esemplare oggetto della descrizione stessa poteva appartenere a tre specie (*C. alcyonipennella* (Kollar, 1832), *C. deauratella*, Lienig & Zeller, 1846 e *C. trifolii* (Curtis, 1832)) e decise quindi di indicare *tuscaemiliella* come *taxon incertae sedis* proponendo di erigere un neotipo qualora fosse stata confermata la scomparsa dell'esemplare originale.

All'inizio del 2008 tuttavia, Willi Sauter di Illnau (Svizzera), dopo aver consultato il World Catalogue e in merito alla sinonimia *mayrella* = *tuscaemiliella*, mi ha scritto dicendomi che l'olotipo di *tuscaemiliella* era stato chiesto in prestito nel 1960 dal Prof. M. Delucchi, dell'Istituto di Entomologia dell'"Eidgenössische Technische Hochscule" di Zurigo, che si stava occupando della lotta biologica contro una *Coleophora* del gruppo *trifolii* dannosa alle coltivazioni di trifoglio nella Nuova Zelanda. Nel corso della ricerca, Delucchi ottenne effettivamente in prestito dal Museo di Storia Naturale di Milano l'olotipo di *tuscaemiliella* e il Prof. Sauter eseguì la preparazione dei genitali dell'esemplare constatando che si trattava di *Coleophora alcyonipennella* (Kollar, 1832). Sauter mi ha inoltre comunicato che l'esemplare fu restituito al Museo di Milano nel 1990.

Sulla base di questa informazione, ho scritto al Museo di Milano, ricevendo poi l'esemplare in studio unitamente al vetrino del preparato genitale.

L'esemplare, in buone condizioni di conservazione, è provvisto dei seguenti cartellini: "Typus" [scritto a mano]; "Emilia Mandriole 20 – VII – 20 A. Fiori" [a mano e stampa]; "Col. tuscaemiliella Costantini (recte tuscoaemiliella)" [a mano]; "alcyonipennella sens. Toll ♂ GP. 1 W.Sauter" [a mano e stampa]; "HOLOTYPUS ♂ Coleophora tuscaemiliella Costantini G.Baldizzone teste, 2008" [rosso, a stampa].

L'esame dell'apparato genitale eseguito da Sauter ha quindi confermato la sinonimia:

Coleophora alcyonipennella (Kollar, 1832) = *C. tuscaemiliella* Costantini, 1923 **syn. nov**.

Ringraziamenti: Desidero ringraziare vivamente l'amico Prof. Willi Sauter di Illnau (Svizzera) per avermi comunicato tutto quanto sapeva sul *typus* di *tuscaemiliella*, fornendomi gli elementi per ricercarlo e il Dr. Fabrizio Rigato del Museo Civico di Storia Naturale di Milano per la sua gentile e pronta collaborazione.
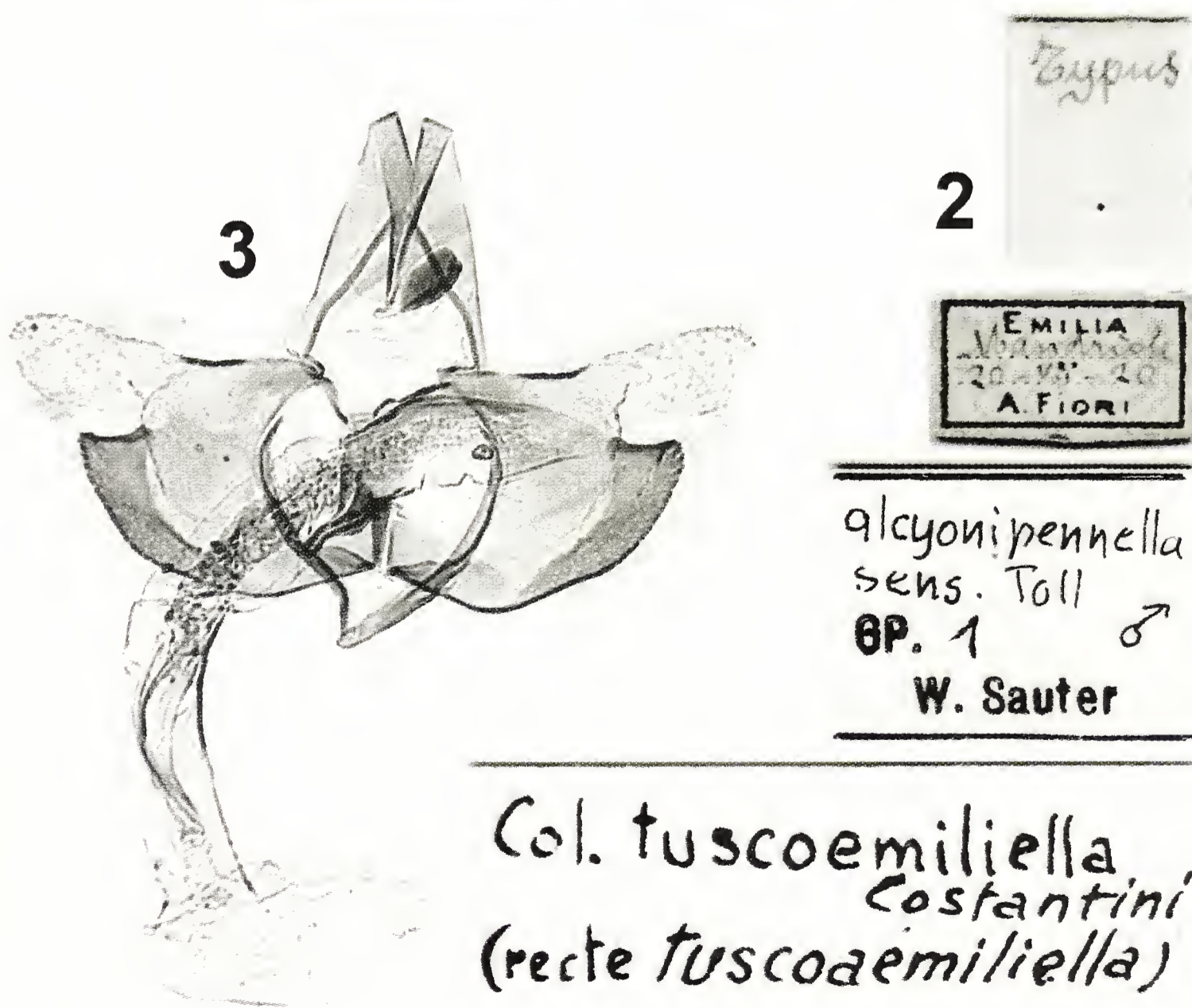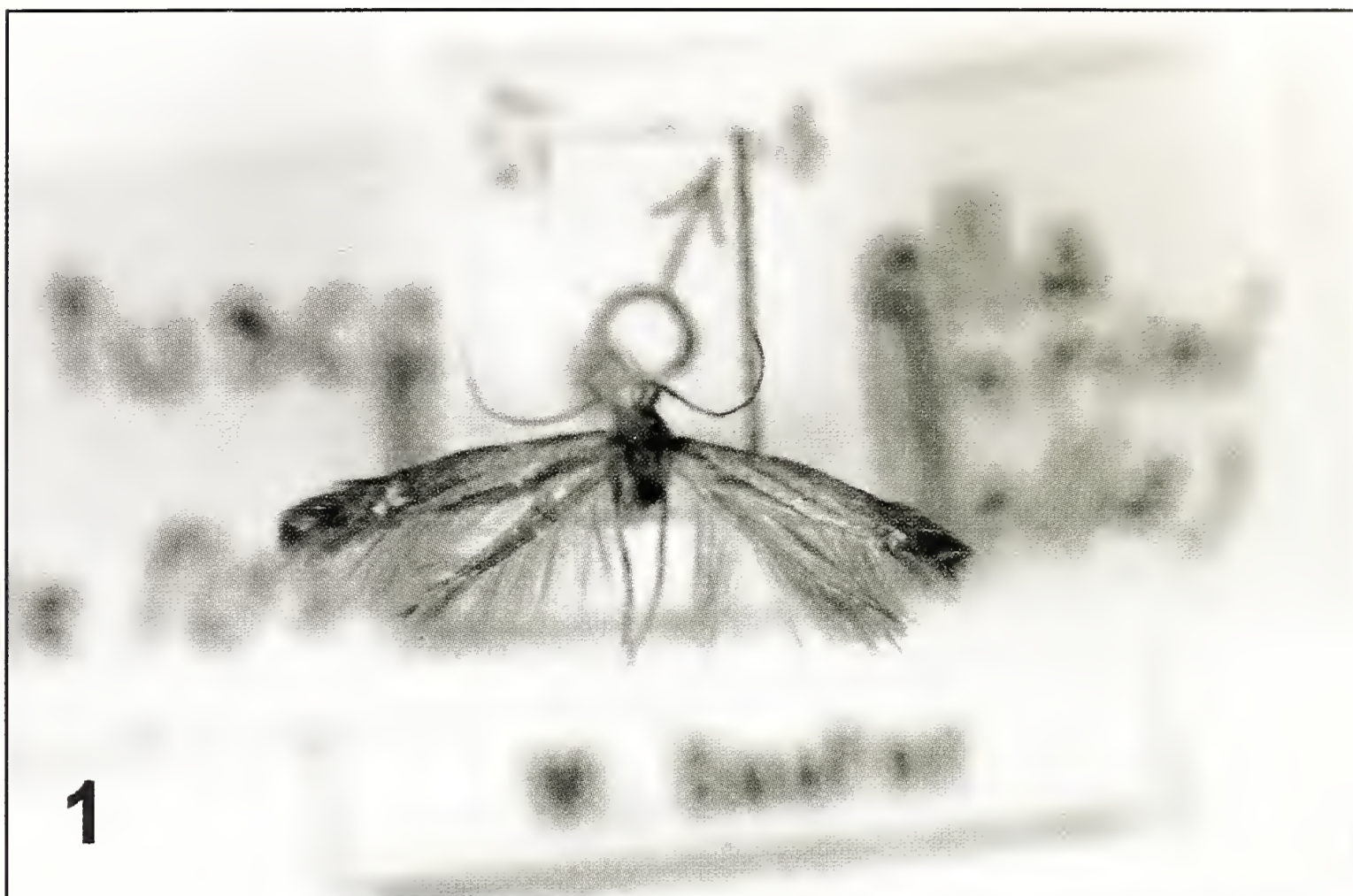
Fig. 1 - *Coleophora tuscaemiliella* Costantini, 1923. 1) olotipo/holotypus. 2) cartellini originali dell'olotipo/original labels of the holotype. 3) apparato genitale/genitalia.

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Cronaca Sociale

Verbale dell'Adunanza del 27 Marzo 2008, ore 18.00

Ordine del giorno: 1) comunicazioni della Presidenza, 2) lettura e approvazione del verbale dell'Adunanza precedente, 3) approvazione del Bilancio consuntivo 2007, 4) ammissioni nuovi Soci e Soci dimissionari, 5) varie ed eventuali.

1) Il Presidente Carlo Violani saluta i convenuti e ringrazia i Consiglieri e i Soci per quanto realizzato nel 2007, anno del 150° anniversario della fondazione della nostra Società.
   Comunica che anche la mostra la mostra "La Società Italiana di Scienze Naturali e l'Ateneo pavese" organizzata dal Prof. Lamberto Laureti presso la Biblioteca dell'Università di Pavia nel Gennaio 2008 ha ottenuto un discreto successo.
2) Il Segretario Claudio Bellante dà lettura del verbale dell'Adunanza del 12 Dicembre 2007, che viene approvato da tutti i Soci.
3) Il Tesoriere Mami Azuma illustrastra le voci principali del Bilancio consuntivo 2007, mettendo in evidenza una perdita di € 8.298,00, la maggior parte della quale è dovuta alla riduzione delle entrate inerenti le quote sociali del 2007. Il Revisore dei Conti Aldo Oriani comunica che il Bilancio consuntivo 2007 è stato analizzato dal Collegio dei revisori che si esprime favorevolmente per la sua approvazione. Il Bilancio consuntivo 2007 viene approvato all'unanimità.
   In riferimento al Bilancio consuntivo 2007, il Socio Lamberto Laureti interviene sull'argomento "quote sociali" proponendo una minor flessibilità nell'inviare le riviste ai Soci non in regola con il pagamento delle quote. Il Socio Guido Peri interviene segnalando che la mancanza di regolarità nell'uscita della RIO potrebbe indurre i Soci a versare le quote in ritardo e suggerisce alla Direzione/ Redazione di RIO di cercare di garantire l'uscita della rivista, possibilmente due volte all'anno, Giugno e Dicembre a distanza di effettivi sei mesi e non in un'unica soluzione alla fine dell'anno come è avvenuto negli ultimi tempi. Propone infine di eliminare le otto pagine gratuite riservate agli Autori Soci e di definire una scadenza massima per il pagamento delle quote. Il Presidente e i Consiglieri prenderanno in esame queste proposte.
4) Il Segretario Claudio Bellante dà lettura dei nominativi dei nuovi Soci che vengono ammessi all'unanimità e comunica i nominativi dei Soci dimissionari.

Non essendovi null'altro da deliberare, il Presidente ringrazia tutti i presenti e scioglie l'Adunanza alle ore 19,15.

Il Presidente	Il Segretario
Carlo Violani	Claudio Bellante

Verbale dell'Adunanza del 18 Dicembre 2008, ore 18.00

Ordine del giorno: 1) comunicazioni della Presidenza, 2) lettura ed approvazione del verbale dell'Adunanza precedente, 3) approvazione Bilancio preventivo 2009,4) ammissione nuovi Soci, comunicazione soci dimissionari, 5) presentazione del nuovo Centro Studi Ottimizzazione Biologica, 6) varie ed eventuali.

1) Il Presidente Carlo Violani ringrazia e saluta i presenti. Ringrazia il Comitato Organizzatore del 57° Campionato Mondiale di Ornitologia che si terrà a Piacenza dal 23 al 25 gennaio 2009 al quale la SISN è stata invitata ad essere presente con uno spazio dedicato alle sue attività e alle riviste. Il Presidente conferma la sua personale presenza e quella della SISN alla manifestazione. Il Presidente informa che la società CODICE che cura la mostra "Darwin 1809-2009" che si terrà a Roma e a Milano, ha richiesto in prestito l'originale della lettera di Charles Darwin, allora Socio Corrispondente SISN, che è conservata nel nostro Archivio storico e conferma la disponibilità al prestito, già deliberata in sede di Consiglio Direttivo.
2) Il Segretario Claudio Bellante dà lettura del verbale dell'Adunanza del 27 marzo 2008 che viene approvato da tutti i Soci.
3) Il Tesoriere Mami Azuma presenta il Bilancio preventivo 2009, conferma che non ci sono variazioni consistenti nei confronti dei precedenti bilanci. Il Bilancio preventivo 2008 viene approvato all'unanimità.
4) Il Segretario Claudio Bellante dà lettura dei nominativi dei nuovi Soci che vengono ammessi all'unanimità e comunica i nominativi dei Soci dimissionari.
5) Alberto Minetti, responsabile del Centro Studi di Ottimizzazione Biologica, presenta gli obiettivi del centro studi e illustra uno studio sulla biologia motoria del cavallo nel sistema postale espresso. Il riassunto della presentazione viene allegato al verbale.
6) Alcuni Soci chiedono quale sia l'attuale consistenza dei Soci. Il Consiglio Direttivo segnala che dopo alcuni anni di progressiva diminuzione numerica dei Soci, nel 2008 si raggiunta una certa stabilità con circa 520 Soci in pari con le quote sociali. Si illustra l'operazione di recupero dei Soci e per il 2009 ci si pone un obiettivo di incremento.
   Il Socio Veronesi lamenta la qualità di alcuni grafici tavolta pubblicati su Natura, la Direzione/redazione della rivista ne prendono atto.

Non essendovi null'altro da deliberare, il Presidente ringrazia tutti i presenti e scioglie l'Adunanza alle ore 19.15.

Il Presidente	Il Segretario
Carlo Violani	Claudio Bellante

Attività sociali 2008

Come di consueto, anche nel 2008 la SISN ha partecipato, in qualità di ospite dello stand offerto dall'organizzazione al Museo di Storia Naturale di Milano, alla mostra-mercato "Preziosa" tenutasi a Novegro (Milano) il 22 novembre, esponendo le proprie riviste. Il 14-16 maggio era presente alla mostra "Mineral Show" di Bologna e il 10 maggio ha partecipato all'"Open Day" promosso dal Museo di Storia naturale di Milano.

Pubblicazioni
MEMORIE
Volume XXXVI, Fascicolo I - Gabriele Galasso, Giorgio Chiozzi, Mami Azuma & Enrico Banfi (A cura di). Le specie alloctone in Italia: censimenti, invasività e piani di azione. Milano, 27-28 Novembre 2008.
ATTI
Volume 149, Fascicoli I-II
NATURA
Volume 98, Fascicolo 1 - Agnese Visconti (A cura di). Il legno brucia: l'energia del fuoco nel mondo naturale e nella storia civile. Atti del convegno. Milano 20 e 21 settembre 2007.
Volume 98, Fascicolo 2 - Stefania Nosotti & Giorgio Teruzzi. I rettili di Besano-Monte San Giorgio.
RIVISTA ITALIANA DI ORNITOLOGIA
Volume 77, Fascicolo 2 e Volume 78, Fascicolo 1

Attività dei Centri Studi

Centro Studi di Esobiologia
Coordinatore: Daniele Venturoli

L'attività del Centro Studi di Esobiologia (CSE) della SISN nel 2008 è stata piuttosto ridotta rispetto agli anni precedenti, a causa degli altri impegni professionali dei propri membri. Le iniziative principali si sono comunque dirette anche l'anno passato secondo i fini del CSE, cioè la divulgazione verso il grande pubblico dei temi principali di questa disciplina e dei risultati più importanti ottenuti dai ricercatori in questo campo.

In particolare, come accade da diversi anni, è continuata la collaborazione con il Prof. Telmo Pievani, docente di Filosofia della Scienza alla Facoltà di Scienze della Formazione dell'Università Milano-Bicocca.

Inoltre, Daniele Venturoli e Gianluca Ranzini, rispettivamente coordinatore e segretario del CSE, hanno portato a termine la stesura (insieme alla Dr.ssa Marta Erba) di un saggio per la casa editrice Bollati Boringhieri nel quale vengono trattate le influenze, vere e presunte, della Luna nei confronti della vita (vegetale, animale e umana) sul nostro Pianeta. Ad alcune parti del volume, che sarà prossimamente dato alle stampe, ha collaborato anche Carlo Biancardi, del Centro Studi di Faunistica dei Vertebrati. L'esobiologia, infatti, è una disciplina trasversale che si occupa, sotto molteplici forme e accomunando diverse aree scientifiche, della ricerca della vita nello spazio e delle condizioni che l'hanno resa possibile sul nostro Pianeta.

Attività svolte nel 2008

29 marzo: conferenza di Gianluca Ranzini su "Costellazioni zodiacali e costellazioni… normali", nel ciclo "Tra cielo e Terra: viaggio tra astrologia, misteri e cospirazioni", organizzato da SISN e CICAP. Aula magna del Museo Civico di Storia Naturale di Milano.

17 aprile: Daniele Venturoli ha tenuto una lezione introduttiva all'esobiologia nell'ambito del corso di Filosofia della Scienza del Prof. Telmo Pievani, Facoltà di Scienze della Formazione dell'Università Milano-Bicocca.

26 ottobre: conferenza di Gianluca Ranzini su "Pianeti extrasolari: metodi di ricerca e risultati", convegno ICARA 2008 (Italian Congress of Amateur Radio Astronomy), Planetario di Milano.

Novembre: Daniele Venturoli ha scritto le voci "Esobiologia" e "SETI" per l'opera "Il futuro della Terra" della UTET.

Centro Studi Storico Naturalistici
Coordinatore: Aldo Oriani

Nel corso del 2008 l'attività dei membri del Centro Studi è proseguita sui consueti filoni di ricerca ed ha prodotto le seguenti pubblicazioni:

Oriani A., 2008 – Dati storici sulla presenza e distribuzione degli Ungulati (Ungulata, Artiodactyla) sulle Alpi e Prealpi della Lombardia e della Svizzera italiana. *Atti Società Italiana Scienze Naturali e Museo civico Storia Naturale Milano*, Milano, 149 (2): 253-272.

Razzetti E. & Violani C., 2009 – Le ricerche di Carlo Jucci sul baco da seta (1897-1962). In: Il contagio vivo. Agostino Bassi nella storia della bachicoltura. Mazzarello P. & Rovati C. (a cura di). *Fonti e studi per la storia dell'Università di Pavia*, Milano, 54: 121-133.

Rovati C., Maretti S., Razzetti E. & Violani C. (eds.), 2007 – Animali dal mondo. La collezione dello zoologo Pietro Pavesi 1844-1907. *Greppi Editore*, Pavia: 1-208.

Rovati C., Ghisoli C. & Violani C., 2007 – Figli dell'aria. Le raccolte ornitologiche del Museo di Storia Naturale dell'Università di Pavia. *Skira,* Milano: 1-151.

Rovati C., Barbagli F. & Violani C., 2007 – The waxworks by Angelo Maestri (1806-1889) preserved in the Museum of Natural History of the University of Pavia, Italy. *Archives of Natural History*, London, 34 (2): 259-271.

Visconti A., 2008 – Colonialismo, scoperte geografiche e conoscenze naturalistiche. *Treccani*, Roma. (www.treccani.it/site/scuola)

Visconti A., 2008 – Ermenegildo Pini e la produzione siderurgica lombarda tra Sette e Ottocento: maestri fonditori, impianti e combustibili sulla via dell'efficienza energetica. In: Atti del Convegno "Il legno brucia: l'energia del fuoco nel mondo naturale e nella storia civile". Visconti A. (a cura di). Milano 20 e 21 settembre 2007. *Natura*, Milano, 98 (1): 169-180.

Visconti A., 2008 – Scienza, natura e amministrazione del territorio dalla Repubblica cisalpina al Regno d'Italia: il ruolo del barnabita milanese Ermenegildo Pini. In: Istituzioni e cultura in età napoleonica. Brambilla E., Capra C. & Scotti A. (a cura di). *Franco Angeli*, Milano: 270-295.

Visconti A., 2008 – Suolo e sottosuolo dall'assolutismo asburgico all'età napoleonica. Il mutare dei ruoli dei boschi e delle miniere nelle alte valli lombarde. In: Organizzazione del potere e territorio. Contributi per una lettura storica della spazialità. Blanco L. (a cura di). *Franco Angeli*, Milano: 173-187.

Visconti A., 2008 – Paesaggi lombardi tra sfruttamento, salvaguardia e nuove sensibilità: situazioni e prospettive. In: Paesaggi: l'anima dei luoghi. Bonesio L. & Micotti L. (a cura di). *Diabasis*, Reggio Emilia: 141-152.

Visconti A., 2008 – Piante esotiche e "benessere dei sudditi": gli esperimenti della Società Patriotica di Milano (1776-1796). In: Atti del Convegno "Le specie alloctone in Italia: censimenti, invasività e piani di azione". Galasso G., Chiozzi

G., Azuma M. & Banfi E. (a cura di). Milano 27-28 novembre 2008. *Memorie della Società italiana di Scienze Naturali e del Museo Civico di storia Naturale di Milano*, Milano, 36 (1): 88.

Visconti A., 2008 – The Naturalistic Explorations of the Milanese Barnabite Ermenegildo Pini (1739-1825) Along the Coast of Calabria: New Observations and Implications with Regard to his Views on the History of the Earth. In: Scientific Exploration in the Mediterranean Region. Corti C., Barbagli F., Ghiselin M. T. & Leviton A. E. (edited by). *California Academy of Sciences*, San Francisco.

Alcuni membri hanno inoltre tenuto conferenze e partecipato a convegni:

Gavagnin P., Ghirardi M., Costa S. & Civallero V. – Distribuzione storica del gatto selvatico europeo (*Felis s. silvestris* Schreber, 1775) nell'arco alpino occidentale. Poster presentato al Convegno "Biologia e conservazione dei Felidi in Italia". Santa Sofia (FC), 7-9 novembre 2008.

Oriani A. – "L'avventura africana: dall'acquisto di Assab (12 marzo 1882) alla "svendita" di Cassala (31 dicembre 1897)". Biblioteca comunale di Barzio, Barzio (LC), 24 luglio 2008.

Oriani A. – "Armenia: l'isola più orientale dell'Occidente". Biblioteca comunale di Barzio, Barzio (LC), 21 agosto 2008.

Centro Studi Faunistica dei Vertebrati

Coordinatore: Roberta Castiglioni, Carlo Biancardi (da Dicembre 2008)

Il Centro Studi Faunistica dei Vertebrati (CSFV) si è costituito alla fine del 1997. Finalità del Centro Studi è promuovere e coordinare attività di studio sui Vertebrati, attraverso contatti fra istituzioni scientifiche, ricercatori e studenti, con la costituzione anche di gruppi di lavoro per la realizzazione di progetti di ricerca o tesi di laurea. Prioritaria, in questo quadro, la collaborazione con la sezione di Zoologia dei Vertebrati del Museo Civico di Storia Naturale di Milano e la Direzione del Museo stesso.

Rientrano negli scopi del Centro Studi anche le attività volte a favorire l'incontro fra ricercatori, studenti e semplici appassionati, attraverso l'organizzazione di conferenze, incontri-dibattito o serate di studio e discussione riguardanti vari aspetti della zoologia dei Vertebrati o delle Scienze Naturali in genere.

Nel corso del 2008 diversi membri del CSFV hanno partecipato alle seguenti iniziative:

- Tre giorni col Gipeto. 6-8 Giugno 2008, Val Martello, Parco Nazionale dello Stelvio. Iniziativa divulgativa in occasione della liberazione dell'ultimo gipeto nel Parco Nazionale dello Stelvio.
- VII Congresso Nazionale Societas Herpetologica Italica. 1-5 Ottobre 2008, Oristano.
- Workshop: Ricerche naturalistiche in provincia di Sondrio. 22 Novembre 2008 presso il Museo Civico di Storia Naturale di Morbegno (SO).
- Convegno: Le specie alloctone in Italia: censimenti, invasività e piani di azione. 27-28 Novembre 2008. Centro Congressi Fondazione Cariplo, via Romagnosi 6, Milano. Promosso dalla Regione Lombardia, Direzione Generale Qualità dell'Ambiente e dal Museo di Storia Naturale di Milano.

Alla fine del 2008 è stato avviato un progetto di ricerca nell'Oasi Lago Boscaccio (MI), per la realizzazione di una tesi di laurea in Scienze Naturali, presso l'Università degli Studi di Pavia (Relatore: Prof. Giuseppe Bogliani). Lo studio, promosso dal nostro Centro Studi, è volto alla caratterizzazione qualitativa della microteriofauna presente nell'Oasi attraverso l'analisi di borre di strigiformi e sessioni di cattura. L'analisi delle borre si effettuerà nel 2009 presso il laboratorio del Museo Civico di Storia Naturale di Milano. Inoltre, anche quest'anno, è proseguita l'attività di monitoraggio di alcune popolazioni di Ululone dal ventre giallo (*Bombina variegata*) in provincia di Bergamo, nell'ambito del progetto dal titolo "Ecoetologia di *B. variegata* in Lombardia", in corso, presso il nostro Centro Studi, da oltre 10 anni (coordinatore: Anna Rita Di Cerbo).

Centro Studi Ottimizzazione Biologica
Coordinatore: Alberto Minetti

Il Centro Studi Ottimizzazione Biologica (CSOB) fu fondato nel 1998 da Alberto Minetti e Franco Saibene (Istituto Tecnologie Biomediche Avanzate del CNR). Una conferenza di McNeill Alexander, Fellow della Royal Society e autorità universalmente riconosciuta nel campo del movimento umano ed animale, presso il Museo Civico di Storia Naturale costituì nel dicembre 1998 la prima iniziativa del CSOB.

Oggi, a dieci anni di distanza, il CSOB si ricostituisce con l'intento di attrarre giovani biologi, medici, veterinari e ingegneri biomedici a discutere e produrre ricerche sull'ottimizzazione biologica in ambito umano e comparato, che poi possano essere pubblicate sulle riviste della Societá ed altre internazionali. La prima iniziativa di questo nuovo corso del Centro Studi si è svolta il giorno 11 dicembre 2008, con la Conferenza dal titolo: Il Cavallo nei Sistemi Postali – una storia di ottimizzazione biologica, tenuta dal Prof. Alberto Minetti, Coordinatore del Centro Studi.

Lo studio dei meccanismi biologici spesso invita i ricercatori a ragionare in termini di ottimizzazione. Comprendere un fenomeno in molti casi coincide con la conoscenza del comportamento del sistema quando le variabili in gioco sono perturbate rispetto ai valori 'standard'. Configurazioni di valori 'standard' possono essere considerate come 'ottimizzate' quando una qualsiasi deviazione da esse porta ad un peggioramento in termini di consumo energetico, lavoro meccanico, depauperamento di risorse, aumento della complessità, riduzione dei fattori di sicurezza, e così via. Ne sono esempi due fenomeni che riguardano la respirazione e la locomozione. Per una certa ventilazione alveolare, e per una data velocità di cammino, esistono frequenze 'ideali' di respiro e di passi che minimizzano il dispendio metabolico. Queste frequenze ottimali nascono dal fatto che esiste un compromesso tra lavoro meccanico statico e dinamico (respirazione) e tra lavoro meccanico esterno ed interno (locomozione), tale per cui la loro somma é maggiore per frequenze inferiori o superiori a quella ideale.

Il fascino di questi studi nasce anche dal legame tra ottimizzazione biologica e selezione evolutiva, laddove specie differenti hanno intrapreso vie alternative per risolvere lo stesso problema funzionale. Ulteriore attrazione è provocata dalle cosiddette 'trappole evolutive', situazioni che non rappresentano la soluzione ottimale assoluta di un problema ma che per una determinata specie costituiscono il massimo raggiungibile senza riconfigurare drasticamente la struttura esistente.

Il processo di ottimizzazione, che può essere esemplificato come 'minimizzazione degli sforzi per la massimizzazione del risultato', interessa studiosi di provenienza culturale eterogenea (medici, biologi, biomeccanici, botanici, veterinari, biochimici, ecc.) che condividono metodi e strumenti di indagine. Strumenti presi dalla matematica (calcolo differenziale ed integrale, teoria del caos, frattali), dalla fisica (meccanica razionale, fluidodinamica, termodinamica), dalla statistica (analisi decisionale, calcolo delle probabilità, cluster analysis) e dall'informatica (tecniche iterative, simulazioni) sono il patrimonio comune di questi ricercatori.

Un primo progetto del Centro Studi, partito nel dicembre 2008, riguarda lo studio dei determinanti biomeccanici del galoppo rotatorio e del galoppo traverso nei quadrupedi. Nel prossimo futuro il CSOB si prefigge di dar vita anche alle seguenti iniziative: cicli di conferenze su argomenti generali, incontri serali periodici, cineteca naturalistica specializzata in locomozione, archivio informatico di pubblicazioni sull'ottimizzazione biologica (consultabile sul sito Internet della SISN), progetti di ricerca multicentrici (multi-museali connessi attraverso la rete), supporto alla didattica museale per la realizzazione di sale e rassegne tematiche. Coinvolgere giovani dottorandi e ricercatori in ricerche miranti ad estendere concetti di ottimizzazione acquisiti nell'uomo ad altre specie, attività che avrebbero come supporto, ad esempio, materiale reperibili in ambito museale. Inoltre, il Centro Studi potrebbe prendersi carico della supervisione di tesi di laurea in Biologia e Medicina.

Grazie al carattere multidisciplinare degli studi di ottimizzazione biologica, il CSOB potrebbe ben relazionarsi agli altri Centri Studi della SISN.

NORME PER GLI AUTORI

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Sono accettati solamente manoscritti originali e inediti. È prevista una sezione "Note e Comunicazioni".
La Redazione si riserva il diritto di accettare o meno i manoscritti ad essa pervenuti per la pubblicazione, dopo averli sottoposti al parere del Comitato di Redazione e/o di Revisori di volta in volta indicati dallo stesso. **Manoscritti non conformi alle norme di presentazione di seguito indicate non sono presi in considerazione**.

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Devono essere presentati su CD etichettato e in 3 copie cartacee. Le copie cartacee devono essere presentate su fogli numerati, di formato A4, stampati su una sola facciata e con doppia interlinea.
Il testo può essere redatto in italiano o in inglese, con un riassunto in entrambe le lingue che comprenda la traduzione del titolo. Le parole-chiave (da indicarsi obbligatoriamente) e le didascalie di illustrazioni e tabelle devono essere sempre riportate sia in italiano che in inglese. Gli Autori sono pregati di far revisionare l'intero testo in lingua straniera, a loro carico, da persona competente. Non sono accettati manoscritti con significative carenze grammaticali e linguistiche.
Il nome e il cognome dell'Autore/i devono essere indicati per esteso e precedere il titolo, che deve essere breve ed essenziale. L'indirizzo dell'Autore/i (eventualmente completo di e-mail) va riportato in nota al piede della prima pagina. Il testo dovrebbe essere preferibilmente suddiviso in: Introduzione, Materiali e metodi, Risultati, Discussione e Bibliografia.
Tutte le illustrazioni sono considerate figure. Devono essere presentate in originale e in triplice copia cartacea, numerate, complete del nome dell'Autore/i e di didascalie. I costi di eventuali illustrazioni a colori sono a carico dell'Autore. Le illustrazioni presentate su supporto digitale devono essere ad alta risoluzione, in formato TIF. La gabbia massima della pagina è: base cm 12,2, altezza cm 19,6. La posizione delle figure deve essere segnalata nel testo.
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Brandbyge J., 1993 – Polygonaceae. In: The families and genera of vascular plants. Flowering plants. Dicotyledons. Magnoliid, Hamamelid and Caryophyllid families. Kubitzki K., Rohwer J. G. & Bittrich V. (eds.). *Springer*, Berlin, 2: 531-544.
Commissione svizzera per la conservazione delle piante selvatiche CPS – Lista nera. <http://www.cps-skew.ch/italiano/lista_nera.htm> (ultima consultazione 2 febbraio 2007).
Fraser N. C. & Rieppel O., 2006 – A new protorosaur (Diapsida) from the Upper Buntsandstein of the Black Forest, Germany. *Journal of Vertebrate Paleontology*, Northbrook, 26 (4): 866-871.
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